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ABSTRACT

To assess the effects of wide aptitude differences on the acquisition of military knowledges and skills, a sample of 183 Army recruits was divided into three maximally distant aptitude groups on the basis of Armed Forces Qualifying Test (AFQT) scores: high aptitude (AFQT 90-99); middle aptitude (AFQT 45-55); low aptitude (AFQT 10-21). Recruits were individually trained to a performance criterion in differing combinations of eight tasks (simple and choice monitoring, M-14 rifle assembly and disassembly, missile preparation, military symbols, the international phonetic alphabet, combat plotting) representative of Army training. Various supplementary psychometric, scholastic achievement, and basic combat training attainment data were analyzed. Results were consistent in demonstrating large differences related to aptitude. As groups, high aptitude individuals excelled, low aptitude individuals did poorly, and middle aptitude groups fell in an intermediate range on all measures. (The document includes seven references and 29 tables and figures.) (LY)

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Aptitude Level and the Acquisition of Skills and Knowledges in a Variety of Military Training Tasks

by

Wayne L. Fox, John E. Taylor, and John S. Caylor

HumRRO Division No. 3 (Recruit Training)

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FOREWORD

The research reported here is part of an overall research effort under Work Unit SPECTRUM to develop procedures for selecting and organizing training content and training methods to achieve more effective training across the spectrum of aptitude. This report concludes Work Sub-Unit SPECTRUM II, the purpose of which was to clarify the relationship between aptitude level and the acquisition of military skills and knowledges. Research for this study was conducted from January 1967 through June 1968.

The research was conducted by HumRRO Division No. 3 (Recruit Training) at Fort Ord, California; the Director of Research is Dr. Howard H. McFann.

Military support for the study was provided by the U.S. Army Training Center Human Research Unit. Military Chief of the Unit during the conduct of the study was LTC David S. Marshall; the present Chief is LTC Robert J. Emswiler.

The research was carried out by Dr. Wayne L. Fox, Dr. John E. Taylor, and Dr. John S. Caylor. Military Assistants were SP 4 William S. Eagleson, SP 4 Dale L. Smith, PFC Everett E. Goodwin, and PFC James F. Hertzog.

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Meredith P. Crawford
Director
Human Resources Research Office

SUMMARY AND CONCLUSIONS

Military Problem

The Army has the problem of training men of widely differing aptitude levels in a variety of military jobs. Recent Department of Defense decisions to lower mental standards for induction and enlistment to the statutory minimum AFQT score is resulting in a greater concentration of lower aptitude trainees in the Army training program. Increasing the number of low aptitude trainees will not only make the training job more difficult but may also result in marked loss in performance by the more apt as they become even more bored and restless than evidenced in the past.

Current technology of training provides little information useful to the Armed Forces for designing training programs to accommodate the entire spectrum of aptitude. Although research directed toward engineering of training for those in lower mental Category IV has been started, results are not yet structured or specific enough to tell how to conduct training. With the Army's training population now spread so widely across the spectrum of aptitude, research is needed on the relationship of training performance to aptitude in order to determine what, if any, differential training is required for the efficient production of relatively standard MOS-qualified soldiers.

Research Problem

The relationship between aptitude level and training performance must be clarified before recommendations for increasing training efficiency can be made. This report presents research aimed at providing this information. Specifically, this report deals with the relationship between aptitude level and the acquisition of military skills and knowledges in a variety of training tasks which differ in complexity.

Method

One hundred and eighty-three U.S. Army recruits were divided into high, middle, and low aptitude groups on the basis of Armed Forces Qualification Test (AFQT) scores. Groups of high, middle, and low aptitude subjects were trained on differing mixes of eight training tasks. The tasks were: simple and choice visual monitoring tasks, M-14 rifle assembly and disassembly tasks, a missile preparation task, learning the phonetic alphabet and a selected group of map symbols, and a combat plotting task.

Instructional methods were selected to maximize the low aptitude recruits' opportunity to learn. Where practical, instruction was automated to ensure standardization and clarity, using audio-visual presentation including slides and video tape. Verbal instructions were given in simple language with ample pictorial examples. All instruction was conducted individually with an instructor present to give prompts, answer questions, and provide immediate knowledge of results after each response.

Results

The results were consistent in demonstrating large differences among recruits of differing aptitude level on all eight training tasks. In general, the low aptitude subjects were slower to respond, required more training time to attain a specified criterion, needed more guidance and repetition of instruction, and were decidedly more variable as a group than the middle and high aptitude subjects. Depending on the particular task, low aptitude subjects required from 2 to 4 times as much training time, from 2 to 5 times as many trials to reach criterion, and from 2 to 6

times as much prompting as did the high aptitude subjects. The learning performance of the middle aptitude subjects was typically intermediate between that of the high and low aptitude groups, but more like the high aptitude groups.

Supplementary psychometric data (Army Classification Battery and Aptitude Area scores) and information on scholastic achievement (years of school completed, reading and arithmetic proficiency) showed the high aptitude subjects to be decidedly superior to the low subjects, with middle aptitude groups scoring in an intermediate range. On the several ACB subtests the percentage of low aptitude subjects who scored above 100 ranged from 1% to 37%, middle aptitude percentages ranged from 45% to 76%, and high aptitude percentages ranged from 73% to 100%. For the several derived Aptitude Area scores, the percentages of subjects who scored above 100 ranged as follows: low aptitude, 0% to 24%; middle aptitude, 48% to 79%; and high aptitude, 87% to 100%. In reading, scores for low aptitude subjects spread rather evenly across the grade level range of 0 to 11, whereas 71% of the middle aptitude group and 94% of the high aptitude group read at or above the 12th grade level. For the low, middle, and high aptitude groups respectively, 92%, 55%, and 13% had completed only 12 or fewer years of schooling.

Follow-up data on these same subjects' performance in BCT showed the same general relationships. On a composite measure of BCT attainment, ATT 21-2, whether the material was cognitive or primarily motor, high aptitude trainees were superior to middle aptitude trainees, who in turn surpassed the lows. Here, as on the task battery, the middles approached the highs. For the low, middle, and high aptitude groups respectively, 33%, 62%, and 66% scored above the median score of the combined distribution.

Conclusions

The findings from this study led to the following conclusions:

(1) Mental aptitude, as measured by the AFQT, relates consistently to a variety of important psychometric and operational criteria, including:

(a) Performance on the Army's psychometric tests for classification and assignment.

(b) Scholastic achievement as indicated by scores on reading and arithmetic tests, and by school grade level completed.

(c) Army basic training performance as shown on a wide variety of tests of knowledge and skill in cognitive and motor subject matter areas, and a measure of leadership potential.

(2) Learning performance is directly related to aptitude level. This relationship holds across a variety of training tasks which differ in complexity. This relationship is demonstrated by an array of response measures which show that:

(a) In some tasks aptitude groups differ only in rate of learning.

(b) In some tasks aptitude groups differ both in rate of learning and in final level of performance.

(c) In simple response tasks aptitude groups differ in both speed and accuracy of response.

(d) The time required to train low aptitude recruits and high aptitude recruits to comparable levels differs substantially.

(e) The learning performance of middle aptitude groups is more similar to that of high aptitude groups than it is to low aptitude groups.

(f) Performance variability relates inversely to aptitude level. Not all recruits labeled as being of low aptitude are slow learners on all tasks; on each task, a few show performance typical of the middle and high aptitude groups.

(g) The requirement for instructor guidance and prompting is related inversely to aptitude level.

The relationship of aptitude to the aforementioned measures is a consistent and powerful one with important implications for the efficient conduct of training. High and middle aptitude groups generally outperform low aptitude groups by a wide margin. These findings, considered in the light of related studies, imply that the efficient training of men at all levels of aptitude will depend upon (a) the recognition of individual differences in aptitude, and (b) the design of instructional programs that are compatible with individual differences in learning rate and final performance capability.

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Aptitude Level and the Acquisition of Skills and Knowledges in a Variety of Military Training Tasks

Chapter 1

INTRODUCTION

Since 1950 the Armed Forces Qualification Test (AFQT) has been used by the Armed Services to determine an individual's eligibility for military service. The AFQT, a written mental aptitude test, is regarded as a general measure of trainability in military subjects. A score falling at the tenth centile on the AFQT standardization distribution is the statutory minimum set by Congress for acceptance into the military.

As the need for manpower has varied over time, the Armed Services have adjusted their mental standards for enlistment and induction. Following the Korean conflict the mental standards were gradually raised, but in October 1966, under Project 100,000, the Department of Defense announced its decision to lower mental standards for induction to the statutory minimum.

The decision to implement Project 100,000 is resulting in large numbers of marginal aptitude trainees appearing in the Army training program. Indications are that marginal aptitude trainees (defined by AFQT centile scores ranging from 10 to 20) will constitute about 25% of the input to the Army training system. This increase in the number of marginal trainees will be likely to increase the difficulty of the training job, requiring more effort on the part of Army instructors to bring these people—with their typical histories of difficulty and frustration in school activities—up to minimum acceptable levels.

Anticipated training problems are not, however, limited to the training of marginal aptitude personnel. It has been common practice in military instruction to have students of all aptitude levels enter a course together, use the same instructional materials, progress at the same rate, and leave the course together. The instructor, in order to keep attrition rates at a minimum, orients his instruction to the slower trainees. This forces, on the entire class, a slowed pace that may well have an adverse effect upon the motivation and achievement of the higher aptitude trainees. Training will inevitably be diluted in an effort to reach the increasing numbers of low aptitude people; consequently, a marked loss in motivation and achievement by higher aptitude trainees may result as they become even more bored and restless than evidenced in the past.[1] Thus, the cost to the Army of accepting large numbers of men from the low end of the aptitude distribution may be twofold—not only sheer difficulty in reaching those of marginal aptitude, but also a negative impact upon higher level trainees.

It would seem axiomatic that the Army cannot achieve a standard, qualified training product by putting widely differing trainees through a standard training mold. Because trainees differ extensively in aptitude, education, and motivation, differential training may be necessary if they are to emerge with comparable skill levels at the end of training.

[1]For example, as shown in a SPECTRUM study reviewing a general supply course, conducted in 1967 by Ernest K. Montague and Morris Showel.

Evidence indicates that individuals progress at different rates for different learning tasks (1, 2); however, the interactions among aptitude, training methods, and learning performance in practical training situations have received little attention. With the Army's training population now spread so widely across the spectrum of aptitude, there is a need for research on the relationship of aptitude to training performance on tasks of varying complexity. This research would determine what, if any, differential training may be required for the efficient production of qualified soldiers across a wide range of MOS-related tasks.

In the interests of developing effective training across all aptitude levels, a research program, Work Unit SPECTRUM, was initiated by the Department of the Army. This research effort was divided into three phases: SPECTRUM I was concerned with the examination of present training problems in the Army Training Centers (3); SPECTRUM II, which is reported here, involved the development of a battery of training tasks typical of Army training, and the subsequent collection of learning data for subjects of different levels of aptitude; SPECTRUM III is under way and involves experimentation with training strategies for achieving more efficient training at all aptitude levels.

The initial step in SPECTRUM II was to develop a training task battery. The selection of tasks for the battery was based on two criteria. The first was that the selected tasks should have elements in common with the skills and knowledges needed in a large number of military jobs. Examination of heavy density MOSs yielded a number of tasks relevant to a variety of military jobs. The second criterion was that tasks should be representative of several levels of complexity. Gagné's (4) taxonomy of learning types served as a general guide for discriminating complexity differences among tasks. Gagné defined eight different types of learning, which he ordered hierarchically from classical conditioning to problem solving. Our first criterion, that tasks be representative of practical military jobs, prevented the selection of pure examples of each learning type as proposed by Gagné. The task battery as finally selected was composed of eight tasks which were roughly placed along a dimension of complexity as outlined in Table 1.

Briefly, the task battery consisted of the following eight tasks, discussed in order of complexity:

Simple Monitoring Task. In this task the subjects were asked to perform a "watchkeeping" function, which involved pressing a response lever when a stimulus light appeared on a display panel.

Choice Monitoring Task. This task was similar to the Simple Monitoring Task except that the subjects responded to one of four possible stimuli by pressing one of four corresponding levers.

Rifle Assembly Task. Subjects were required to learn to assemble the M-14 rifle.

Rifle Disassembly Task. This task was similar to the Rifle Assembly Task except that the subjects were required to learn to disassemble the rifle.

Missile Preparation Task. Subjects were to learn to perform 34 sequential steps necessary to prepare a guided missile for launching.

Military Symbols Task. Subjects were required to learn 26 military map symbols.

Phonetic Alphabet Task. Subjects were required to learn the 26-letter international phonetic alphabet.

Combat Plotting Task. Subjects were required to learn to plot the position of enemy aircraft from information giving the range and bearing of the aircraft.

Table 1

Ordering of Tasks According to Complexity

Dimension of Complexity	Description of Learning Requirements	Task
Simple	Stimulus and response association	Simple Monitoring Choice Monitoring
↓	Learning fixed procedures; either verbal or motor (chaining of verbal or motor responses)	Rifle Assembly Rifle Disassembly (motor procedure) Missile Preparation (verbal procedure)
↓	Multiple discrimination of words and symbols (serial or paired-associate learning)	Phonetic Alphabet Military Symbols
Complex	Learning concepts and principles and their application in a problem situation	Combat Plotting

Succeeding chapters present a detailed description of general methodology and subject attributes (Chapter 2), instructional technique and the presentation of data for each training task (Chapters 2-7), and a general discussion of the findings and their implications (Chapter 8).

Chapter 2

GENERAL METHODOLOGY AND SAMPLE ATTRIBUTES

METHOD

As stated earlier, this study was undertaken to learn the effects of wide aptitude differences on learning a range of laboratory tasks representative of Army training. Since a major focus was on the marginal aptitude trainee, instructional methods were selected to maximize the low aptitude recruit's opportunity to learn. The selection of instructional methods and learning conditions was established, on a judgmental basis, without regard for cost and effort, or for efficiency for the middle and high aptitude groups.

Where practical, training was automated using audio-visual presentation (including slides and video tape) to ensure standardization and clarity. Verbal instructions were given in simple language with ample pictorial examples. All training was conducted individually with an instructor present to give prompts, answer questions, and provide immediate knowledge of results after each response. Material was presented in the smallest possible integral segments. Instructions were repeated or reviewed as appropriate, and practice was provided on each trial. In short, training procedures were tailored to give the lower aptitude trainee the best possible opportunity to learn.

Within the seven hours of training time available for any one subject, it was not possible for him to attempt all eight training tasks. Moreover, because training was individually administered and continued for a variable time until a criterion level of performance had been reached, no fixed set of tasks could be scheduled. Accordingly, different individuals performed different sets of training tasks, accounting for fluctuations in sample size among tasks.

The substantial differences in sample size for different categoris of data were a function of the design and conduct of the study. The choice of tasks to be administered to each of the three new subjects available each day for training was a function of several factors. The training tasks themselves were implemented at different times during the five months of data collection. Since all training was conducted individually, and run for whatever time was required to reach criterion, assignment to training tasks was necessarily contingent upon the availability of subject time, training equipment, and trainer personnel.

Initially, training tasks were assigned to ensure an approximately equal number of both the high and the low aptitude groups for each task. Midway through the data collection, training of middle aptitude subjects was initiated, at which time assessment of reading and arithmetic proficiency was instituted for subjects at all three aptitude levels. Training of the middle aptitude group was concentrated in the five more difficult and complex tasks—judged more appropriate to their aptitude level—because of training time limitations. Information on age, education, AFQT, and ethnic categorization was obtained for all subjects, regardless of the set of training tasks they undertook. Problems of availability and comparability dictated restricting BCT performance data to those subjects completing their initial training at Fort Ord.

For the high and low aptitude groups, sampling of training tasks fell between the extremes of each subject learning all tasks and each subject learning only a single task. Most high and low aptitude subjects were trained in only a few of the eight experimental tasks. For the extreme aptitude groups, this study approached the condition of independent random sampling of subjects for each task.

SAMPLE ATTRIBUTES

The subjects of this study were recruits entering the Army during the period from February to June 1967. Subjects had no previous military experience (defined to include ROTC), National Guard, or reserve duty. After final screening at the Los Angeles Armed Forces Examining and Entrance Station (AFEES), they were sent to Fort Ord, California, for reception processing and basic training. Before beginning formal Reception Station processing at Fort Ord, and typically within three days of having entered the Army, the subjects were taken to the HumRRO laboratory for one day of training on the experimental learning tasks.

Subjects were selected for this study solely on the basis of their scores on the AFQT mental screening measure administered considerably earlier at the AFEES. Three homogeneous and maximally different aptitude levels constituted the experimental groups. The high aptitude group ($\underline{N}$ = 72) was defined by AFQT centile rank scores of 90-99; the middle group ($\underline{N}$ = 30) by centile ranks 45-55; and the low aptitude group ($\underline{N}$ = 81) by centile rank scores of 10, the minimum qualifying score for Army service, through 21. Of the low aptitude group, half had scores of 14 or lower and only 14% scored higher than 17.

Entry Level Characteristics

The age distributions of the three aptitude groups are presented in Table 2.

Education was recorded as the number of years of school completed, as reported to HumRRO experimenters and later reconciled with Army records. The education distributions for the three aptitude groups are shown in Table 3.

The relationship between AFQT score and amount of education is clear. Since the low aptitude group was slightly older than the high, the relationship of AFQT to education must be attributed not solely to age but to differential continuation in the school system. The high percentage of low aptitude men who had completed high school is surprising in that this group was not considered as sufficiently trainable for the Army until the recent relaxation of aptitude requirements under the New Standards Program.

Table 2

Age Distributions of Aptitude Groups

(Percent)

Aptitude Group	Age					*N*
	18-19	20	21	22	23-25	
High AFQT (90-99)	11	36	15	18	20	72
Mid AFQT (45-55)	10	63	7	7	13	29
Low AFQT (10-21)	18	21	20	8	33	81

Table 3

Education Distributions of Aptitude Groups

(Percent)

Aptitude Group	Years of Schooling Completed					*N*
	10 or Fewer	11	12	13	14 or More	
High AFQT	0	1	12	24	63	72
Mid AFQT	13	0	42	22	23	29
Low AFQT	23	16	53	5	3	81

Table 4

Ethnic Distributions of Aptitude Groups
(Percent)

Aptitude Group	Ethnic Designation				*N*
	Anglo	Mexican	Negro	Oriental	
High AFQT	90	0	2	8	72
Mid AFQT	79	11	6	4	29
Low AFQT	38	27	20	15	81

The ethnic distributions for subjects at the three AFQT levels are presented in Table 4. These data should be interpreted with caution. Many factors produce seasonal and other systematic fluctuations in the socioeconomic and ethnic characteristics of Army input. Subjects were drawn from a limited geographical area, primarily Southern California. The time span and extent of the sampling is insufficient to warrant generalization of these ethnic distributions, which are included only as further description of the specific sample.

Reading and Arithmetic Achievement

Reading level was assessed by use of the Gray Oral Reading Test, Form A, selected primarily for its wide range of reading levels.[1] Subjects were required to read aloud short passages ranging from the simple level of "Look, Mother, look," through highly complex material. Scoring was based on completeness and accuracy of oral reading. Distributions of scores, converted to grade levels by use of the published norms, are shown in Figure 1.

The three aptitude groups clearly differed in reading level. The low aptitude group was spread almost evenly between grade level zero, complete inability to read, and the 11th grade level. None of the low AFQT sample reached the reading level attained by 71% of the middle AFQT group and by 94% of the high aptitude group.

Proficiency in elementary arithmetic was measured by a locally devised test of simple items selected from the workbook used in the Supply Handlers Course in Advanced Individual Training. The 12 items of this test were:

1. $\begin{array}{r} 749 \\ +213 \\ \hline \end{array}$
2. $\begin{array}{r} 27862 \\ +1865 \\ \hline \end{array}$
3. $\begin{array}{r} 17625 \\ -\ 739 \\ \hline \end{array}$
4. $\begin{array}{r} 286542 \\ -193663 \\ \hline \end{array}$
5. $\begin{array}{r} 33 \\ \times 33 \\ \hline \end{array}$
6. $\begin{array}{r} 213 \\ \times 78 \\ \hline \end{array}$
7. $16\overline{)3200}$
8. $34\overline{)1156}$
9. $1/3+1/6+7/9=$
10. $1/4-3/16=$
11. $1/2 \times 1/2=$
12. $8/7 \div 16/14=$

One point was awarded for each correct answer, giving a maximum possible score of 12. The distributions of scores on each of the five parts of the arithmetic test for the three aptitude level samples are shown in Table 5.

The Addition subtest was easy for these subjects and discriminated little between aptitude levels. On the other hand, comparison of the percentage of subjects failing all items on a subtest shows values, for the high and low aptitude groups respectively, of 2% vs. 43% for the Subtraction subtest, 4% vs. 21% for the Multiplication subtest, 0% vs. 55% for the Division subtest, and 0% vs. 51% for the Fractions subtest. Comparison of men getting all items in a subtest correct shows an equally extreme and sharp contrast between aptitude levels.

[1]Identification of this commercially available item is for research documentation purposes only; this listing does not constitute an official endorsement by either HumRRO or the Department of the Army.

Gray Oral Reading Test: Percentage Distribution by Grade Level

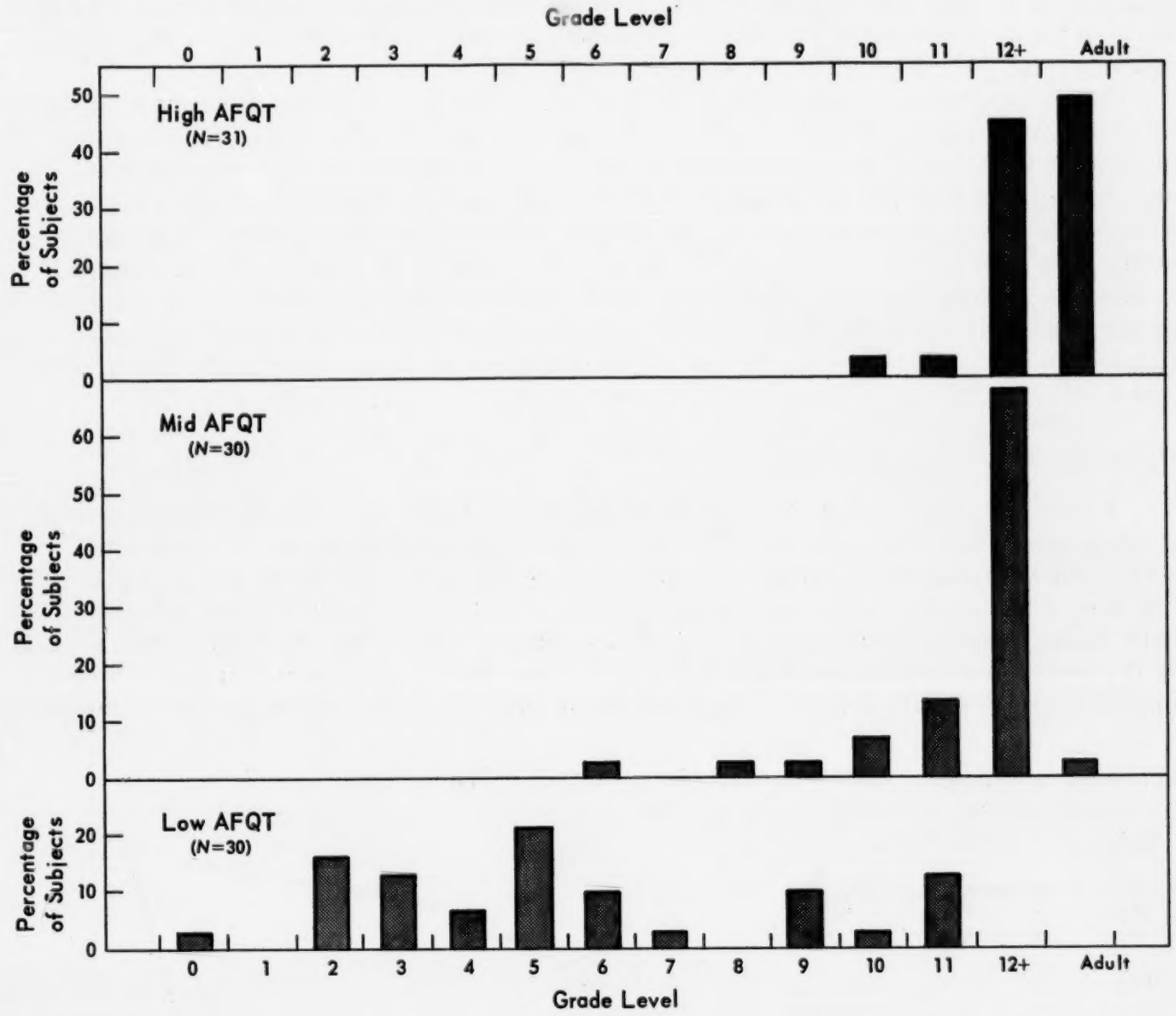

Figure 1

Table 5

Distributions of Part Scores on Arithmetic Test
(Percent)

Aptitude Group	Part Score (Number Correct)																
	Addition			Subtraction			Multiplication			Division			Fractions				
	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2	3	4
High AFQT (*N*=46)	0	4	96	2	11	87	4	34	62	0	9	91	0	4	17	17	62
Mid AFQT (*N*=30)	0	3	97	7	37	56	3	30	67	3	23	74	13	20	17	13	37
Low AFQT (*N*=47)	0	23	77	43	32	25	21	47	32	55	23	22	51	28	17	2	2

No standardization data are available to permit expression of these scores relative to school grade level or the general population in this age group. Nevertheless these arithmetic items do not appear to be of great difficulty. As with reading, the relationship between arithmetic ability and AFQT is clear.

The cumulative percentage distributions of the three aptitude groups on the total score of the arithmetic test are shown in Figure 2. In this figure a point on the curve shows, on the ordinate at the left, the percentage of men in that aptitude group scoring at or below the score indicated on the baseline. Thus, 81% of the low aptitude group scored six or below out of a possible 12 points, while only 14% of the middle AFQT group and none of the high aptitude groups scored no higher than six. Similarly, 59% of the high group, 36% of the middle group, and only 5% of the low aptitude group achieved total scores of 11 or 12 (these are the differences between the percentage of subjects scoring 10 or lower and 100%).

Psychometric Characteristics

Extensive psychometric data were extracted from records of routine Army testing conducted for purposes of classification and assignment. These data were summarized according to the percentage of men in each AFQT group scoring above 100 in the Army standard norm score distribution. Unlike the centile rank norm scores running from 1-100, which are used with the AFQT, the scores of the Army classification tests reported below have been transformed to a normal distribution with an arithmetic mean of 100 and standard deviation of 20 for

Arithmetic Test: Cumulative Percentage of Subjects at or Below Indicated Total Score

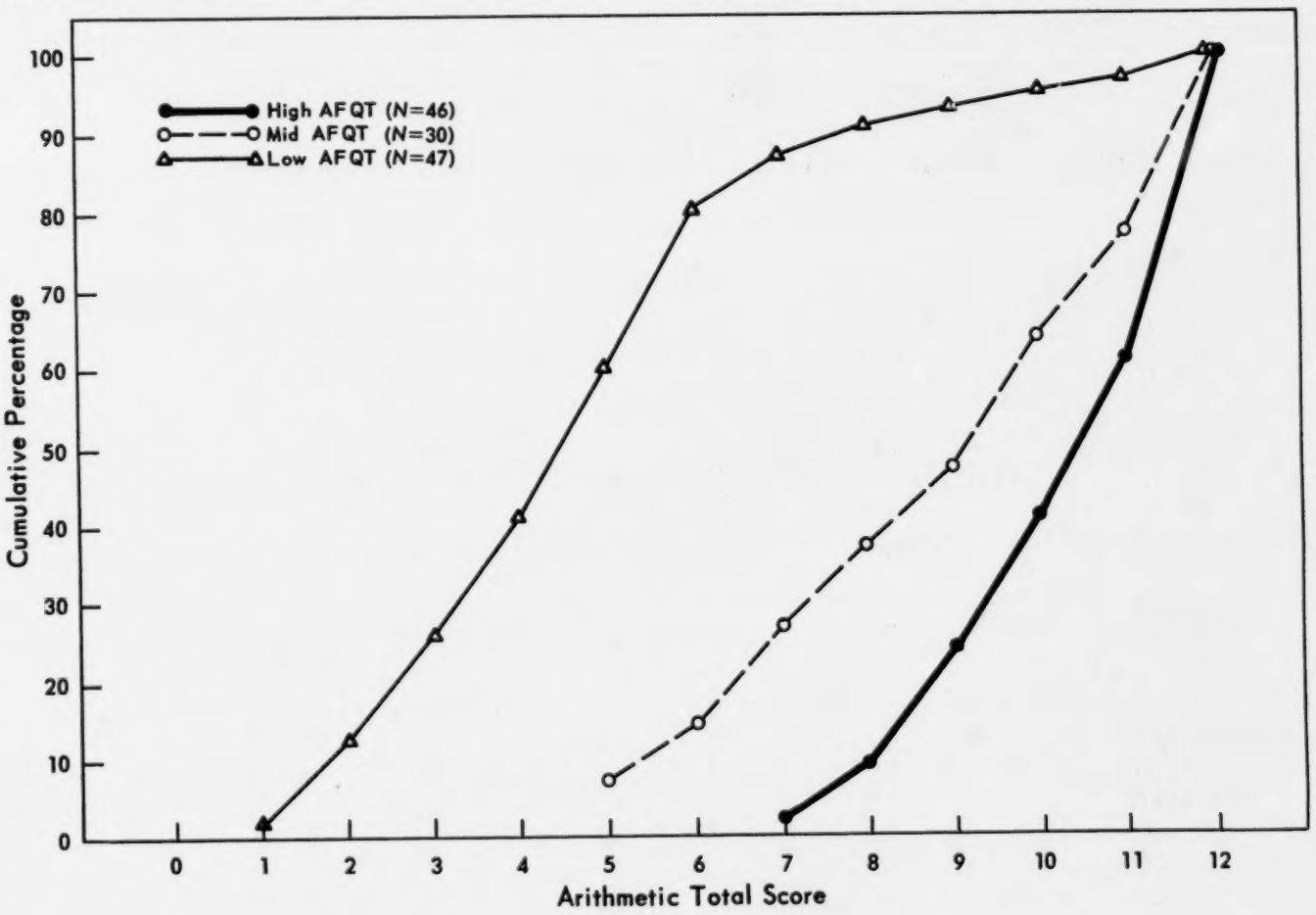

Figure 2

the mobilization population. For several years prior to the advent of Project 100,000 New Standards men, Fort Ord input had typically averaged about 109 on these various measures. The choice of the standard score of 100 as a cutting point represents an estimate of the average middle point of the present distribution of scores.

The percentages of men in each AFQT group scoring above 100 on each of the subtests of the Army's classification and assignment battery are presented in Table 6. Scores from the different subtests of the classification batteries are combined in various weighted combinations to yield Aptitude Area Scores on which selection for MOS training is based.

Table 7 presents information parallel to that of Table 6 for the Aptitude Area Scores generated from the subtests of the Army test battery.

Table 7

Percentages of AFQT Groups Scoring Above 100 in Army Aptitude Areas
(Percent)

Aptitude Area	AFQT Score		
	10-21 (*N* = 79)	45-55 (*N* = 29)	90-99 (*N* = 71)
Infantry - Combat	3	48	87
Armor, Artillery & Engineers - Combat	18	66	99
Electronic	13	55	99
General Maintenance	13	62	100
Motor Maintenance	24	62	100
Clerical	9	79	100
General Technical	0	72	100
Radio Code	8	79	100

Table 6

Percentages of AFQT Groups Scoring Above 100 on Army Classification Tests
(Percent)

Subtest	AFQT Score		
	10-21 (*N* = 79)	45-55 (*N* = 29)	90-99 (*N* = 71)
Verbal	4	76	100
Arithmetic	1	75	100
Shop Mechanics	37	59	96
Pattern Analysis	9	66	100
Army Clerical Speed	32	72	89
Automotive Information	33	59	93
Mechanical Aptitude	14	72	97
Electrical Information	19	45	93
General Information	13	69	96
Classification Inventory	28	45	73
Army Radio Code Aptitude	24	72	94

The frequency distributions on which each row of data in Tables 6 and 7 are based show some slight variability from one subtest or Aptitude Area to another. As a set, however, they can be fairly summarized as typically and consistently showing a wide range of scores for the middle AFQT groups with scores spanning a substantial portion of the full range, from the bottom score of the low AFQT group to the top score of the high group. With equal consistency, there was trivial or no overlap between the classification test score ranges for the high and low AFQT groups.

BCT Performance Characteristics

To this point the data presented have described the sample in terms of pre-existing characteristics, abilities, and attributes which the recruits brought with them into the Army and which were unaffected by their minimal Army experience. Other descriptive information is also available—Army measures of performance in Basic Combat Training (BCT) conducted in the two months immediately following reception processing.

Table 8 presents data on the BCT performance of the sample from two sources: Army Training Test 21-2, the composite measure of performance in BCT training content; and peer ratings routinely obtained from trainees as one basis of selecting candidates for the Leader Preparation Course. Data are

Table 8

Percentages of AFQT Groups Scoring at or Above the Median on BCT Measures
(Percent)

Measure	Percent of Total Possible Score on ATT 21-2	AFQT Score		
		10-21 (*N* = 65)	45-55 (*N* = 28)	90-99 (*N* = 59)
1. Bayonet	3	46	64	61
2. Hand-to-Hand Combat	3	34	57	59
3. Drill & Ceremonies	7	32	25	51
4. Guard Duty	2.5	40	71	61
5. First Aid	4	46	57	58
6. Individual Tactical Training	4.5	42	64	61
Cumulative Subtotal	24	29	57	68
7. Military Justice & Code of Conduct	5	15	54	85
8. Military Conduct & General Subjects	5.5	23	68	80
Cumulative Subtotal	34.5	15	61	76
9. Physical Combat Proficiency Test	7	55	35	56
10. Basic Rifle Marksmanship	8.5	37	52	46
Cumulative Subtotal	50	28	54	75
11. Commander's Evaluation	50	48	58	51
Total	100	33	62	66
12. Leader Prep Peer Ratings		28	48	77
13. Leader Prep Ratings Meeting Screening Standard		12	28	53

presented in the form of the percentage of subjects at each AFQT level scoring above the median score of the combined distribution of the total sample. Because the possible score range for many of these tests is only a few points, and because scores tended to pile up heavily on one or two of the few scores possible, the distribution split occasionally departs markedly from the theoretical model of 50% above and 50% below the median.

Tests 1 through 6 are pure performance tests given at the end of BCT; Tests 7 and 8 are written tests covering cognitive material given at the same time. On each of these tests, to varying degrees, the superior performance of the high AFQT group appears again. Measures 9 and 10 show no relationship to AFQT. Test 11, Commander's Evaluation, based on seven weekly ratings by the Training Company Commander on each of five unique soldierly qualities, similarly shows no relationship to AFQT. In contrast, ratings on leadership potential made by fellow trainees appears to be based to a very high degree on the same factors measured by AFQT, whether treated as percentage of men above the grand median (Measure 12) or of men meeting the absolute level cutoff score for eligibility for Leader Prep training (Measure 13).

SUMMARY

Subjects for this study were newly inducted Army recruits selected solely on the basis of AFQT scores to provide the top, the middle, and the bottom of the aptitude range. The AFQT is composed of four equally weighted subtests covering the diverse abilities of verbal, arithmetic, shop mechanics or familiarity with tools, and pattern analysis or spatial perception skills. So extreme are the cutting points used for the low and high AFQT groups that men had to score, almost uniformly, very low or very high on all four subtests to be included in the extreme groups on the basis of total AFQT score. Men selected for the middle aptitude group could achieve the requisite intermediate total score either by uniformly average performance on all four subtests or by various combinations of high and low performance.

Psychometric Tests

The pattern of psychometric test performance for the three AFQT levels is of a consistency rarely encountered. The high AFQT group performed extremely well in all areas; the low AFQT group performed consistently poorly; and the middle AFQT group falls in an intermediate position, with great individual variability. This is not surprising for many of the abilities measured by the instruments and the Army classification battery, because the same attributes are being measured by both tests, and the test findings serve only to validate and refine the AFQT measures. Thus, the poor performance of the low AFQT groups on the experimental measures of reading and arithmetic merely corrobates the verbal and arithmetic subtests of the AFQT and manifests their low level of ability in these fundamental skills.

As an average of these two measures, the General Technical (GT) Aptitude Area Score, which corresponds most closely to civilian measures of scholastic aptitude or intelligence, serves only to extend the meaning of that portion of the AFQT which depends so heavily on formal education. However, as shown in Table 7 under the General Maintenance Aptitude Area, which is comprised of the other two subtests of the AFQT that do not rely on formal schooling, the low AFQT recruits fared little better than they did on GT. Moreover, they showed no higher aptitude or promise for the combat aptitude areas than they did for the technical areas; they maintained this low level even in the Radio Code Aptitude, which is strictly an auditory test.

BCT Performance

The data on the BCT performance of the three aptitude groups present a different aspect of the picture, representing the differential success of the aptitude groups during their first significant segment of Army performance. Although BCT performance measures do not represent an ideal research criterion and tend to blunt and attenuate relationships, they are the Army's own measures of recruits' performance in fundamental military content learned during the first eight weeks of Army training.

The BCT program is highly standardized and pitched toward the level of the lower aptitude recruit. Not only is it elaborated and redundant but considerable effort is made—both in the formal training program and in individual, supplemental, remedial training—to ensure that almost all men meet graduation standards by passing the test. It resembles the public education system in the strong tendency for those who persevere in the system to graduate—witness the high percentage of low AFQT subjects who had completed high school.

Although differences in BCT performance measures are less marked than differences in classification test data, the pattern remains unchanged—about half again as many high aptitude as low aptitude men exceed the median BCT score. However, these differences are increased when a more demanding criterion than the middle distribution score is used, even to the extremes found with classification test scores—yet the BCT tests cover substantial areas of material deemed essential for all soldiers to know. Less expected is the finding that, for the six performance areas representing primarily motor skills, about half again as many high AFQT trainees exceed the median as do low AFQT subjects. Scores on the Physical Combat Proficiency Test, Basic Rifle Marksmanship, and the Commander's Evaluation section of ATT 21-2 show little or no relationship with AFQT.

On the other hand, the leadership potential ratings received by the subjects from their fellow recruits show the familiar relationship with AFQT almost as markedly as those found with classification test scores. The utility of the peer rating is extended by the demonstrated relationship between similar BCT peer ratings and successful performance throughout the first duty tour (5). This is true also of the composite measure of the BCT performance scores provided by ATT 21-2.

In summary, the entire body of data describing the sample displays a pattern of unusual consistency. As a group, those men scoring high on AFQT excel on all other measures taken; those men low on AFQT display a parallel consistency to do poorly in all areas; and the middle AFQT group shows characteristics falling in the intermediate range between the extremes.

Chapters 3-7 present learning performance data for these three aptitude groups as they underwent varying combinations of individual tasks from the task battery.

Chapter 3

SIMPLE AND CHOICE MONITORING TASKS

The Simple and Choice Monitoring Tasks are considered representative of a number of military tasks requiring visual surveillance or watchkeeping activity. Included would be tasks performed by personnel whose main function is to detect and react to a signal (e.g., switchboard operators, fire control personnel, radar operators, control panel monitors, target acquisition personnel, sentries). These tasks represent the simplest level of complexity included in the task battery.

METHOD

Seventeen High AFQT subjects and 15 Low AFQT subjects performed the Simple Task, and 19 High AFQT and 19 Low AFQT subjects performed the Choice Task.

The apparatus consisted of a stimulus panel, appropriate response levers, and assorted recording devices located in a sound-deadened cubicle. The same basic apparatus was used in both tasks, varying only in the number of response levers available to the subject.

Figure 3 shows the stimulus panel, which was divided into four sections labeled A, B, C, and D. Each section contained two rows of three white lights separated by a single red light. A single lever (as shown in Figure 3) for the Simple Task, and four levers (corresponding to the ABCD panel sections) for the Choice Task were situated in front of the stimulus panel.

The 24 white lights were accompanied by a loud clicking noise and were programed to light one at a time in random sequence at the rate of five per second.

The four red lights were programed to light one at a time at intervals ranging from 15 to 205 seconds in 10-second steps. The resulting 20 interstimulus intervals were randomized with the restriction that each interval appear only once during each task. Each red stimulus light came on a total of five times in random order.

The onset of a red stimulus light automatically shut down the

Monitoring Apparatus for Simple Task

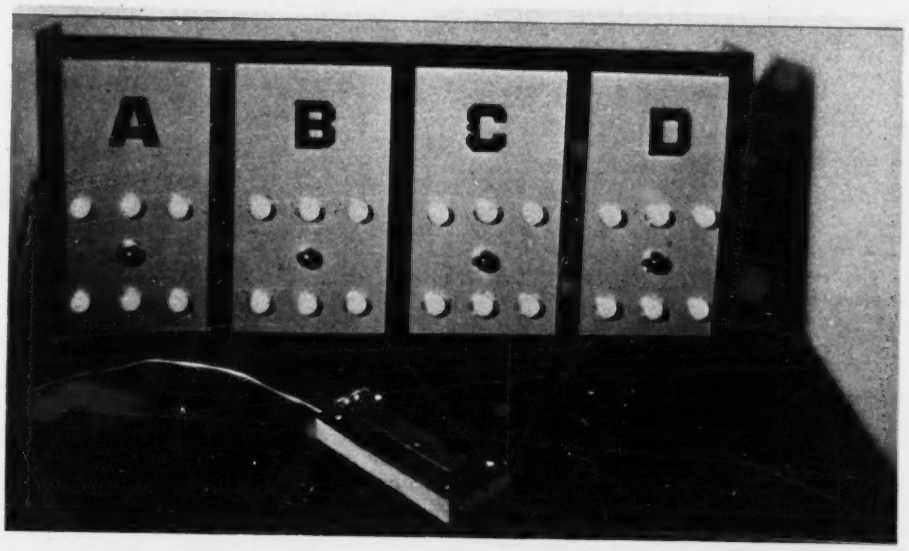

Figure 3

program controlling the white lights so that when a red light was on the white lights were off. The clicking noises that accompanied the white lights, however, continued at the previous rate of five per second during the time the red stimulus light was on. The red light remained on until the appropriate lever was pressed by the subject. Pressing the lever also activated the program controlling the white lights and signaled the beginning of the next interstimulus interval.

Upon entering the testing room, the subject was told that he was to monitor an "Operations Control Panel." It was explained that the flashing white lights indicated that different pieces of information were entering the central control room located next door. It was explained that when too much information was processed through the panel the white lights went off and one of the red lights came on, indicating that no further information could be processed until the "overloaded" circuits were reset. It was the subject's task to reset the circuits by pressing the single lever in the Simple Task, or one of the four levers in the Choice Task. The importance of speed in making his response was emphasized. The stimulus panel was then activated and the subject made a practice response. If there were no questions, the panel was reactivated and the 20 trials ensued.

An instructor was present in the cubicle at all times to monitor assorted timers and event counters, which automatically recorded (a) the response time measured from the onset of the red stimulus light to the activation of the lever, and (b) the number of responses made by each subject. Each presentation of a red stimulus light constituted a trial.

RESULTS

The data were analyzed for measures of response time, individual consistency across trials, and the number of errors or false reactions. Skewed response time distributions on several trials due to a few very long (e.g., 10 seconds) response times dictated the use of medians rather than means as the more representative measure of central tendency.

Median response times are presented in Figure 4 for both high and low aptitude subjects on the Simple and Choice Tasks. The 20 trials on each task are grouped into blocks of four trials each. As expected, longer response times were recorded for the Choice Task than for the Simple Task.

A median score was determined for each subject. Scores were then averaged across subjects in each of the two aptitude groups to provide the data presented in Table 9. The high aptitude subjects made significantly faster responses than the low aptitude subjects on both tasks.

Response consistency was measured by taking the variance of an individual's response times across trials. A Median Test (6) on the frequencies shown in Table 10 indicated that high aptitude subjects were significantly more consistent (less variance from trial to trial) than the low aptitude subjects on the Simple Task. The same trend was found in the Choice Task, but the χ^2 was not significant.

Table 11 presents the means and standard deviations of the false reactions or errors made in both tasks by the aptitude groups. The low aptitude subjects made significantly more false reactions (responding without the red light) on the Simple Task than did the high aptitude subjects. In the Choice Task, differences between groups did not attain statistical significance ($t = 1.55$, $p < .10$) though the trend was again for the low aptitude subjects to make more errors (pressing a wrong lever) than the high aptitude subjects.

Simple and Choice Monitoring Tasks: Median Response Times by Aptitude Level

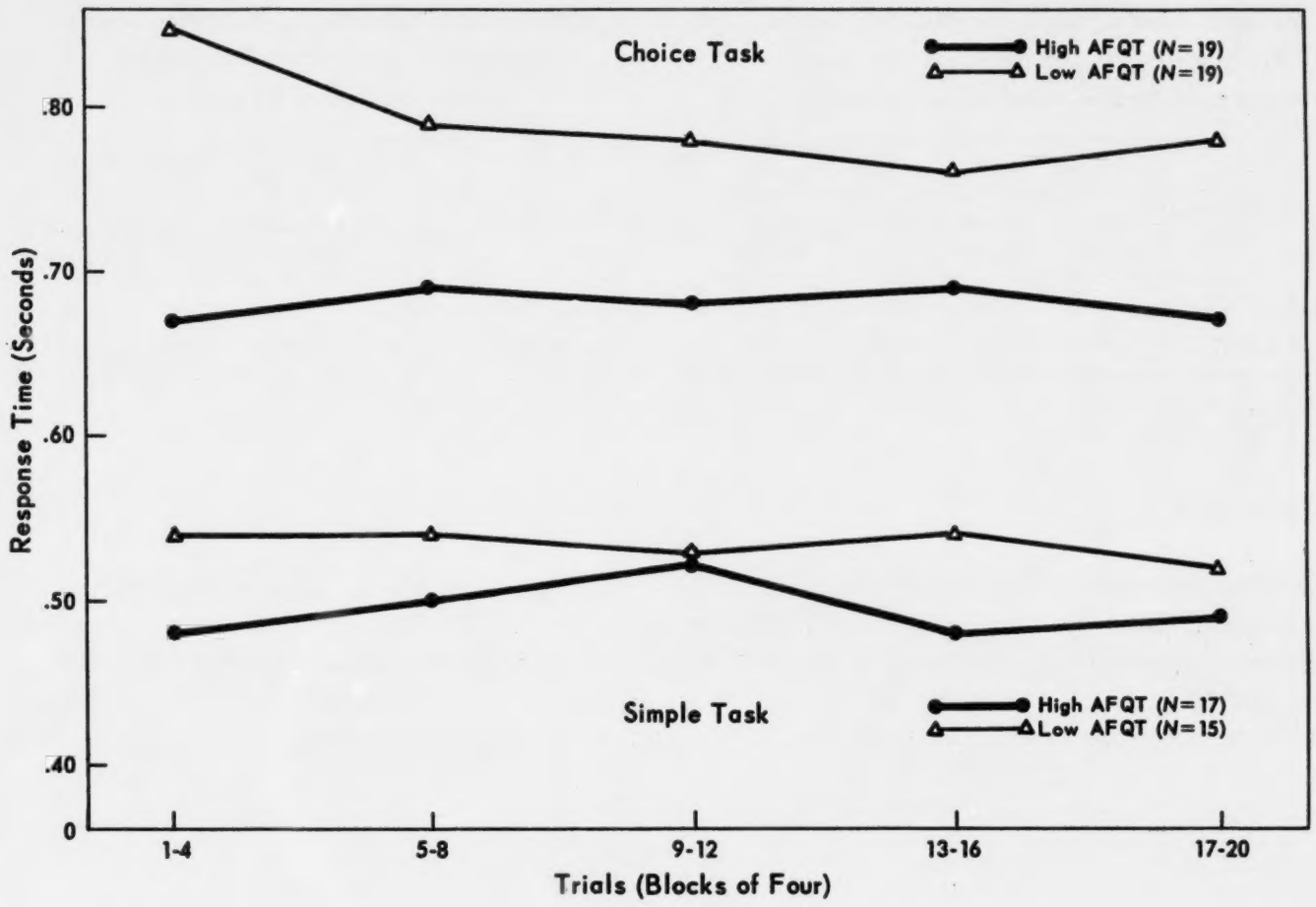

Figure 4

Table 9

Simple and Choice Monitoring Tasks: Group Means and Standard Deviations[a]

Aptitude Group	Simple Task[b]		Choice Task[c]	
	Mean	Standard Deviation	Mean	Standard Deviation
High AFQT	.50	.04	.68	.10
Low AFQT	.55	.07	.79	.12

[a]Comparable analyses were performed using mean response time per trial and yielded essentially the same results reported for the median response times.

[b]$t = 2.63$; $p < .02$.

[c]$t = 3.03$; $p < .01$.

Table 10

Simple and Choice Monitoring Tasks: Frequency of Individual Variances Above and Below Median Response Time

Aptitude Group	Simple Task[a]		Choice Task[b]	
	Above Median	Below Median	Above Median	Below Median
High AFQT	5	12	7	12
Low AFQT	11	4	12	7

[a] $\chi^2 = 6.15$; $p < .02$.
[b] $\chi^2 = 2.63$; $p < .20$.

Table 11

Simple and Choice Monitoring Tasks: Means and Standard Deviations of Errors or False Reactions

Aptitude Group	Simple Task[a]		Choice Task[b]	
	Mean	Standard Deviation	Mean	Standard Deviation
High AFQT	1.0	.7	2.2	2.3
Low AFQT	3.0	3.2	3.5	2.9

[a] $t = 2.41$; $p < .05$.
[b] $t = 1.55$; $p < .10$.

SUMMARY

These results indicate that at relatively simple levels of task complexity, as exemplified by the Simple and Choice Monitoring Tasks, low aptitude subjects displayed poorer performance when compared to higher aptitude subjects. The low aptitude subjects were slower to respond, more variable in their responses, and tended to be less accurate than the higher aptitude subjects.

Chapter 4

RIFLE ASSEMBLY AND DISASSEMBLY

Every man entering military service, except for those conscientious objectors assigned to the medical services, is trained to assemble and disassemble the M-14 rifle. These tasks are fixed-procedure motor tasks, which have elements in common with a variety of tasks performed in many military jobs. In addition to assembly/disassembly procedures, fixed-procedure motor tasks are included in setting up and operating a wide variety of individual and crew-served weapons and in maintaining the whole spectrum of military, mechanical, and electronic equipment. Such fixed-procedure tasks require a series of motor responses that must be performed in a specified order. These rifle tasks were judged to represent a higher level of task complexity than the monitoring tasks discussed in Chapter 3.

METHOD

Seventy-six subjects—23 High AFQT, 30 Mid AFQT, and 23 Low AFQT—were trained to assemble the M-14 rifle, and 38 subjects—18 High AFQT and 20 Low AFQT—were trained to disassemble the rifle. Middle aptitude subjects were not trained on the disassembly task. Subjects were trained on either the assembly or disassembly task, but never on both tasks.

The subject, upon entering the classroom, was told that he was going to learn to assemble (or disassemble) the M-14 rifle, and the general instructional procedure was explained to him. Figures 5 and 6 show the classroom, which included a

Rifle Assembly/Disassembly Apparatus

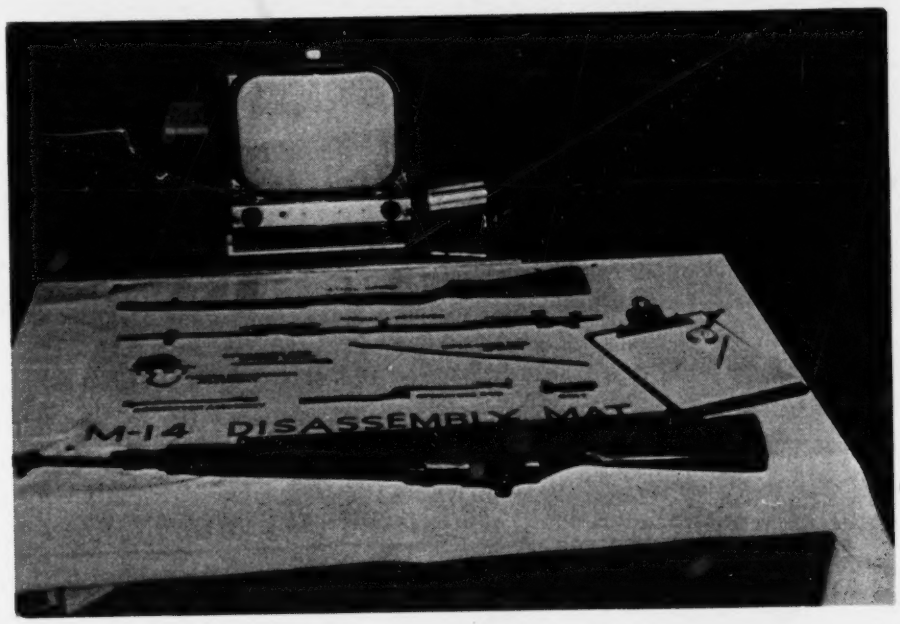

Figure 5

Rifle Instructor and Subject

Figure 6

closed-circuit TV screen, table, standard Army Disassembly Mat for the M-14 rifle, an M-14 rifle, and an instructor.

The subject was led step-by-step through the correct assembly or disassembly procedure by a qualified rifle instructor appearing on video tape. The video tape instructional period ran approximately nine minutes. Both demonstrations were divided into seven distinct steps corresponding to the separate parts of the rifle. At the completion of each step the video tape was stopped, and the subject was directed by the instructor beside him to perform the same assembly or disassembly step on the rifle provided him. This procedure was followed for each of the seven steps until the rifle was completely assembled or disassembled. Completion of a cycle of the seven steps constituted a training trial. After each training trial the subject undertook a test trial during which he attempted to assemble or disassemble the rifle with no aid from the video tape demonstration. Training and test trials were continued until the subject had received a minimum of three training trials, and he stated that he needed no further training. Test trials were continued until the subject showed no further improvement on three consecutive trials in time-to-assemble or -disassemble score.

During both training and test trials a prompt was given by the instructor after 30 seconds if the subject showed no progress, or at any time when aid was requested by the subject. A maximum of three instructor-initiated prompts was given at 30-second intervals for each assembly or disassembly step. The last prompt was given after approximately 90 seconds had elapsed and always ended with instructor-guided assembly or disassembly of the part, or conclusion of the step.

Subjects were told to work as rapidly as possible but not to skip steps or attempt short-cut procedures. The instructor recorded (a) total time-to-assemble or -disassemble the rifle (part times were accumulated during training trials), and (b) the number of prompts given during training and test trials. Following inspection of the data, a response time criterion was determined for each task. Final trial scores for all subjects were used to construct a frequency distribution. The tenth centile was selected as the criterion performance level. This method of criterion selection assured that only extreme cases would be unable

to surpass the criterion. The criterion scores obtained in this way were 70 seconds for the assembly task and 50 seconds for the disassembly task.

RESULTS

Rifle Assembly Task

Rifle assembly mean response times are presented in Figure 7 for the high, middle, and low aptitude groups. Data are presented only through Trial 11 because the N per aptitude group began to decrease differentially after this point as individual subjects reached asymptotic (i.e., stabilized) performance and completed the task. An analysis of variance indicated that the overall AFQT effect was significant ($F = 23.27$; $df = 2,73$; $p < .001$), as was the trials effect ($F = 477.56$; $df = 10,730$; $p < .001$).

The large initial difference among groups became systematically smaller as practice continued, resulting in a significant AFQT-by-trials interaction effect ($F = 21.98$; $df = 20,730$; $p < .001$). Apparently there was a significant differential ability to profit from the first instruction trial. This was true even though none of the subjects had previous experience with the M-14 rifle. The reduction in the magnitude of the differences among groups as a function of practice, however, was not great enough to eliminate the AFQT effect by Trial 11.

Rifle Assembly: Mean Response Time Per Trial

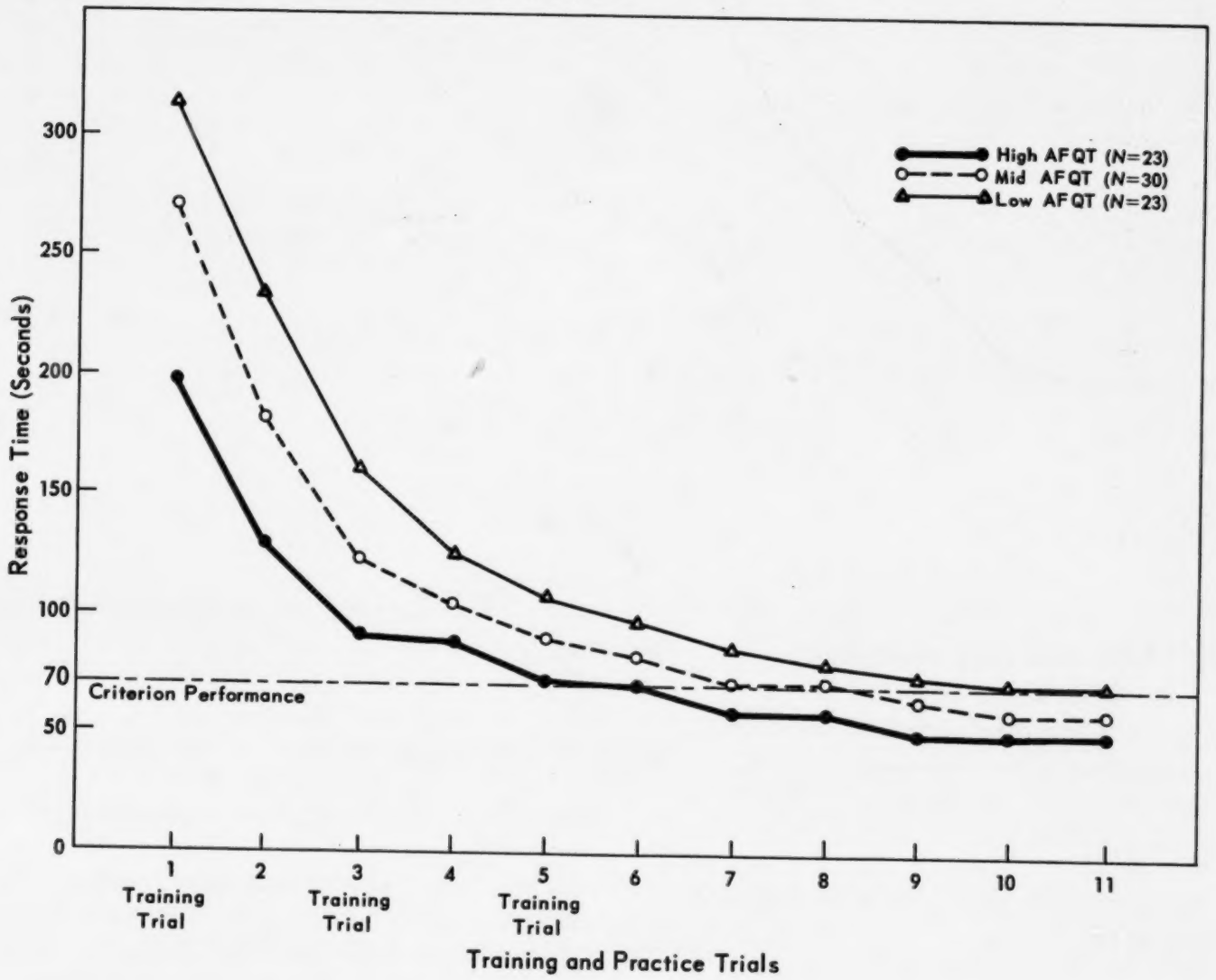

Figure 7

Comparisons of mean response times on the last trial (Trial 11) indicated significant differences among all three groups.

Figure 7 shows that the high and middle aptitude group means bettered the 70-second response time criterion on Trials 6 and 9 respectively, and that the low aptitude group mean was approaching the criterion on Trial 11.

The group means presented in Figure 7 do not permit examination of individual differences in criterion attainment within aptitude groups. To facilitate such a comparison the trial-by-trial cumulative percentage of subjects meeting the 70-second performance criterion for the rifle assembly task is presented in Figure 8. A vertical line erected from the baseline at any trial will show, at its intersection with the three curves, the percent of subjects in each group who have met criterion at the end of that trial. Note, for instance, that by Trial 7, 78% of the subjects in the High AFQT group, 50% of the subjects in the Mid AFQT group,

Rifle Assembly: Cumulative Percentage of Subjects Reaching Criterion Per Trial

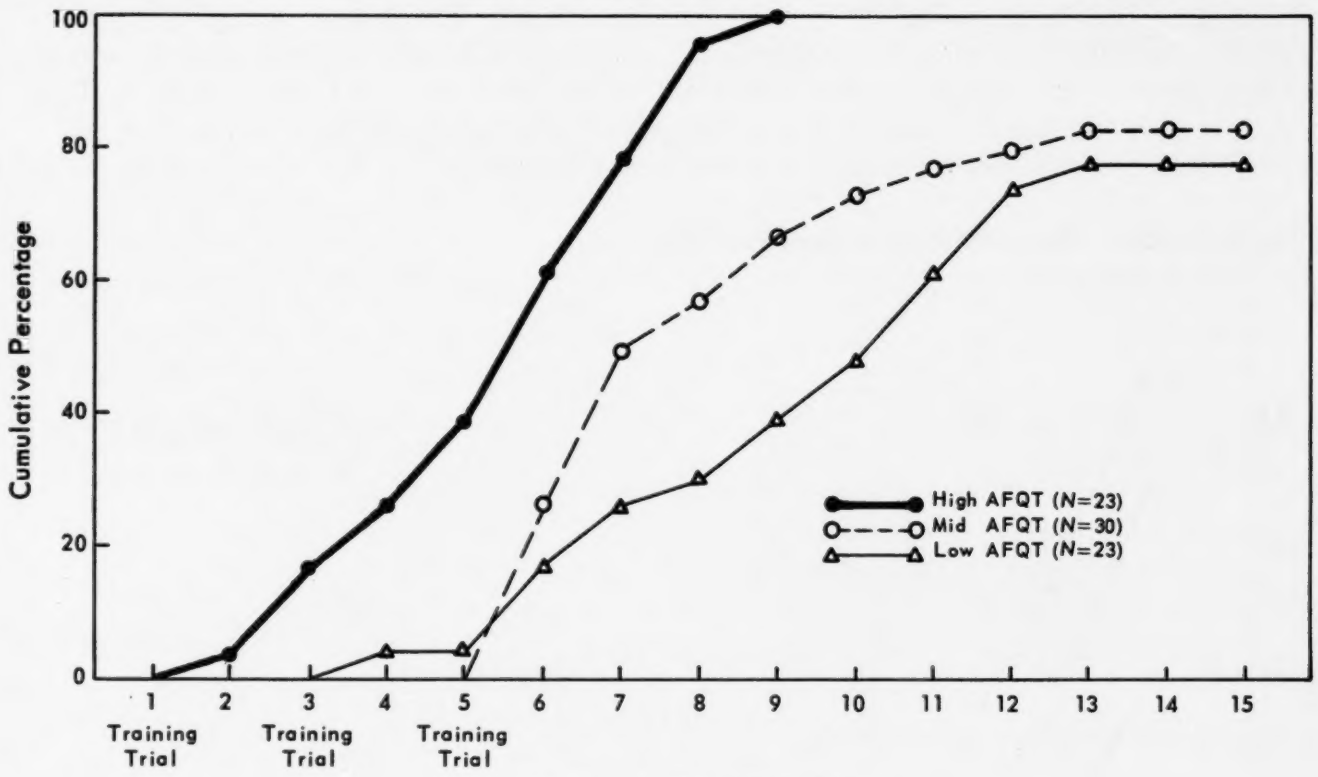

Figure 8

Table 12

Rifle Assembly: Means and Standard Deviations of Prompts Per Group

Aptitude Group	*N*	Mean[a]	Standard Deviation
High AFQT	23	6.4	4.1
Mid AFQT	30	11.3	6.0
Low AFQT	23	16.6	7.9

[a] $F = 15.72$; $df = 2,73$; $p < .001$.

and 26% of the subjects in the Low AFQT had bettered the 70-second criterion. Every man in the High AFQT group had bettered the criterion by Trial 9, but after Trial 15, a substantial percentage of men in the other two groups had yet to attain criterion.

Another measure of task performance was the number of prompts required by subjects during the training and test trials. The mean number of prompts received by each aptitude group is presented in Table 12. The majority of prompts for all three groups

occurred during the first three trials and no further prompts were required after the conclusion of the last training trial (Trial 5).

Rifle Disassemb y Task

The rifle disassembly task yielded data similar to that presented for the rifle assembly task. Rifle disassembly mean response times are presented in Figure 9 for the high and low aptitude groups. Data are presented only through Trial 10 as the N per group began to decrease differentially as individual subjects reached asymptotic performance and completed the disassembly task.

Rifle Disassembly: Mean Response Time Per Trial

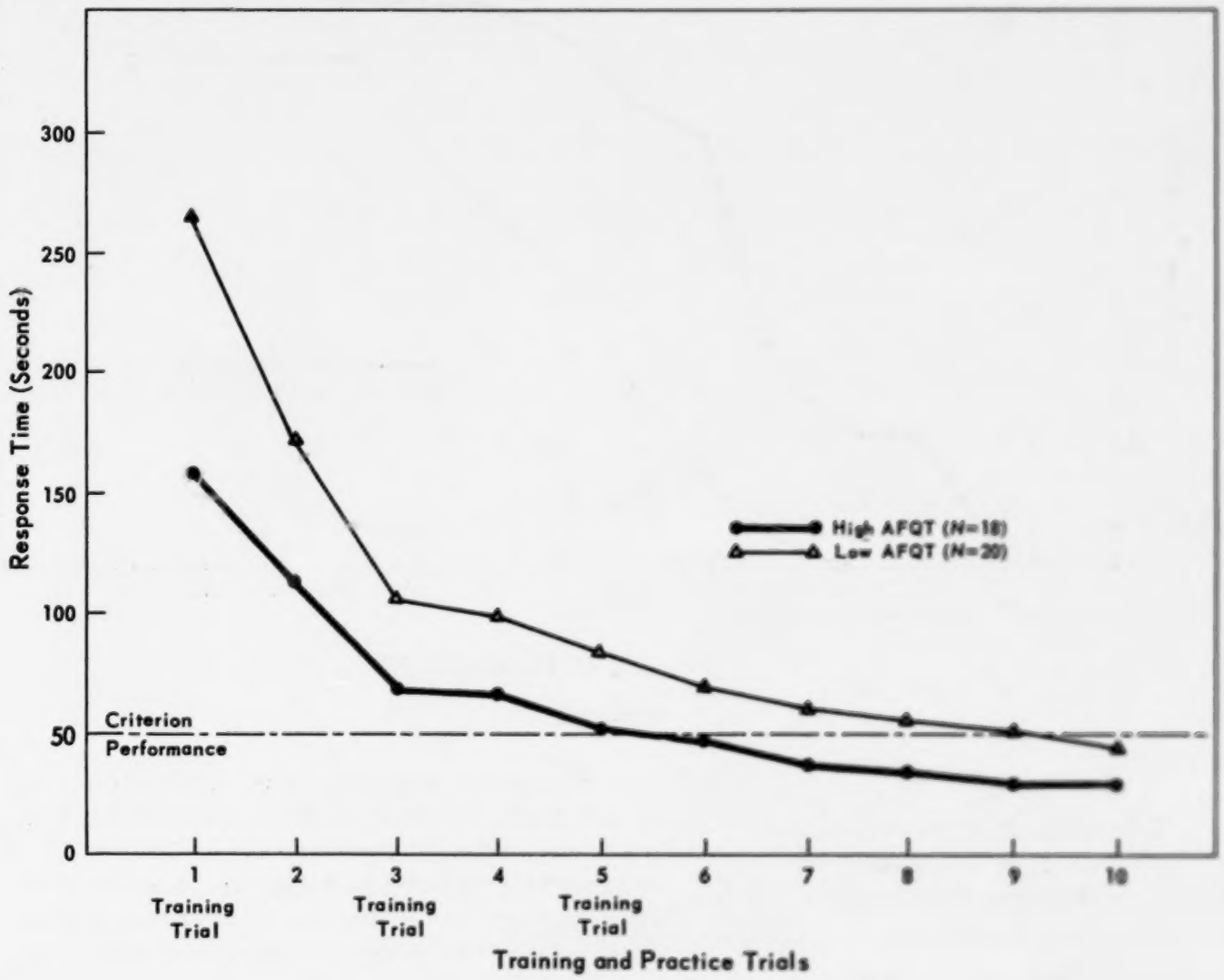

Figure 9

Analysis of variance indicated that the overall AFQT effect was significant ($F = 26.23$; $df = 1,36$; $p < .001$), as was the trials effect ($F = 159.21$; $df = 9,324$; $p < .001$) and the AFQT-by-trials interaction effect ($F = 10.85$; $df = 9,324$; $p < .001$). As in the rifle assembly task, the systematic reduction in the difference between groups (which led to the significant AFQT-by-trials interaction) was not great enough to eliminate the AFQT effect. Here, too, apparently there was differential ability to profit from the initial instruction. Comparison of mean response times on the last trial (Trial 10) yielded a significant difference between high and low aptitude groups. The high aptitude group mean score

bettered the 50-second performance criterion on the sixth trial, while the low aptitude group mean reached this level on the tenth trial.

Curves for the cumulative percentage of trainees reaching the response time criterion on each trial are presented in Figure 10. Note that by the sixth trial 72% of the High AFQT group and 15% of the Low AFQT group had bettered the 50-second performance criterion. All but two trainees in the high aptitude group had bettered the criterion by Trial 8 while one-half of the low aptitude trainees had still to attain criterion at that point.

Rifle Disassembly: Cumulative Percentage of Subjects Reaching Criterion Per Trial

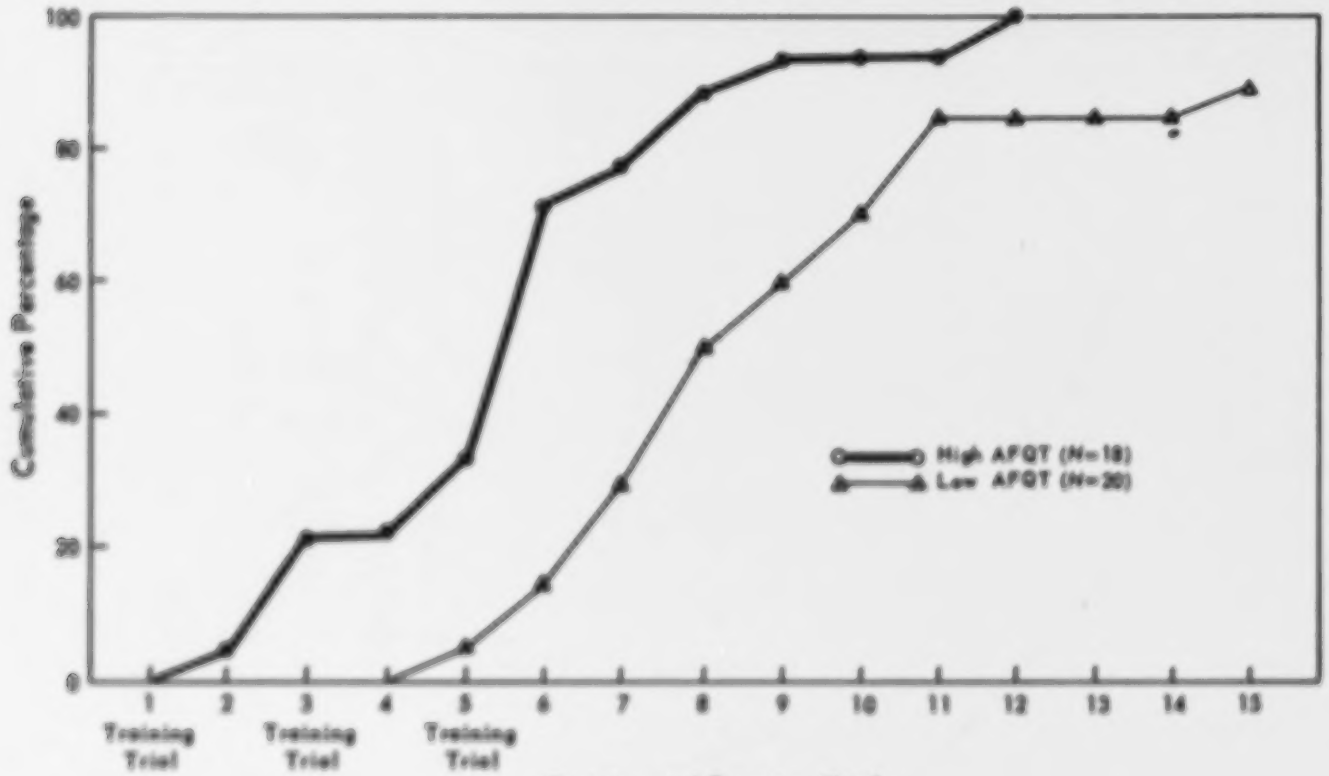

Figure 10

Table 13

Rifle Disassembly: Means and Standard Deviations of Prompts Per Group

Aptitude Group	*N*	Mean*	Standard Deviation
High AFQT	18	5.4	3.7
Low AFQT	20	12.2	5.4

*$F = 19.86$; $df = 1, 36$; $p < .001$.

The mean number of prompts received by the high and low aptitude groups during the disassembly task appear in Table 13. As in the rifle assembly task, the majority of prompts occurred on the first three trials, with no further prompts required after the conclusion of the last training trial (Trial 5).

SUMMARY

Analysis of the rifle assembly and disassembly data indicated there were significant differences in the acquisition of skill in these two fixed-procedure motor tasks among subjects of different aptitude levels. Clearly, all of the subjects learned to perform their assigned task (assemble or disassemble the rifle), but the aptitude groups differed in the time taken to assemble or disassemble the rifle (mean response time), the amount of individualized instruction needed to meet task requirements (prompts), and the number of trials required to attain a specified criterion.

All differences were in favor of the higher aptitude subjects. Low aptitude subjects took about twice as long as high aptitude subjects to acquire minimum proficiency on the tasks, and required more than twice as much individualized help. Where data were available on middle aptitude subjects (on the rifle assembly task), their scores fell midway between the high and low aptitude groups on all the measures.

Large differences were found among subjects in their ability to profit from the initial instruction. This was true even though all subjects supposedly started out even, as none had reported any previous experience with weapons of this kind. On both tasks, these large initial differences in response time gradually reduced as a function of practice; however, final response time performance levels favored the higher aptitude subjects.

Cumulative percentage curves showing the percent of subjects in each group meeting the performance time criteria on each trial showed a wide variability in individual performance within aptitude groups. Some low aptitude subjects were able to attain criterion with a minimum of training and practice, while others did not reach criterion on the last reported trial. On the other hand, a few high aptitude subjects did relatively poorly on the tasks.

Chapter 5

MISSILE PREPARATION

Like the immediately preceding tasks, Rifle Assembly and Disassembly, the Missile Preparation Task is a fixed-procedure task, but it emphasizes learning a series of verbal responses. Verbal procedure tasks are found in many military jobs that require the use of checklists, either explicit or implicit, in setting up and operating equipment (e.g., missile checkout procedures, engine trouble-shooting, setting fuses and preparing charges, preparing aircraft for flight, checking out radios). This task was considered at roughly the same level of complexity as the preceding assembly/disassembly tasks.

Missile Preparation Training Device

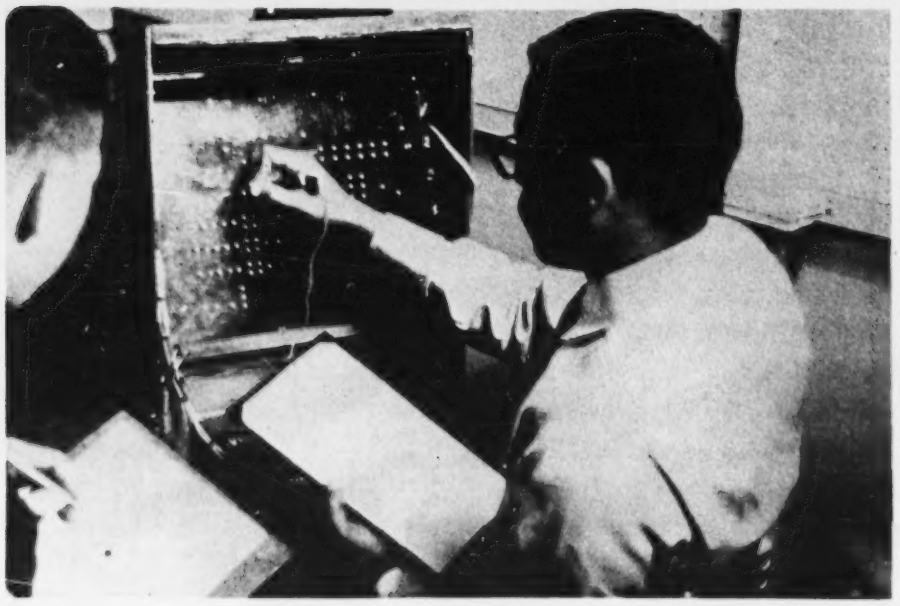

Figure 11

METHOD

Twenty High AFQT subjects, 25 Mid AFQT subjects, and 21 Low AFQT subjects participated in the Missile Preparation Task, which was a 34-step procedure intended to prepare a guided missile for launch. The procedure was performed on a specially designed training device (Figure 11) that simulated a guidance system control panel.

Each of the 34 steps in the procedure required a single response, which consisted of touching an electronic stylus to one of approximately 100 electrical contacts located on the screen of the training device. The subject, the training device, and the instructor were all in a small soundproof room. After the subject was oriented to the task at hand the correct procedure was demonstrated by the instructor, who carefully explained the purpose of each of the 34 steps and pointed out the corresponding electrical contacts on the training device. At the conclusion of the demonstration, the subject was given a written checklist containing a short description of each of the 34 steps in proper sequence. The subject was given the opportunity to read through the checklist (or have it read to him, if he chose) and ask questions before the beginning of the first training trial. The checklist was available to the subject throughout the task.

In addition to providing the checklist during each training trial, the instructor gave verbal prompts or pointed out the correct electrical contact to the

subject when he failed to make a correct response. The subject was allowed seven seconds to make each correct response. A correct response was followed by the cycling of the training device to present the next step in the sequence. Nothing happened when the subject made a wrong response, and the number of responses that could be made during the seven-second interval was unlimited. Failure to make a correct response within the time limit resulted in an automatic spatial prompt by the training device. An arrow appeared on the screen pointing to the correct electrical contact. In addition to the spatial prompt by the machine, the instructor provided an oral prompt from a standardized list corresponding to each of the 34 steps.

The training device automatically recorded the number of prompts and the total time required to complete the 34 steps. Each completion of the 34-step sequence constituted a training trial. Training was continued until the subject required fewer than five prompts per trial or until he had received a total of 15 trials.

RESULTS

The mean number of prompts per trial for the three aptitude groups is presented in Figure 12. Inasmuch as some subjects in each group reached criterion and completed the task in fewer trials than other members of the group, the N per trial was held constant by continuing to record criterion scores for those subjects completing the task before the slowest group member.

Missile Task: Mean Number of Prompts Per Trial

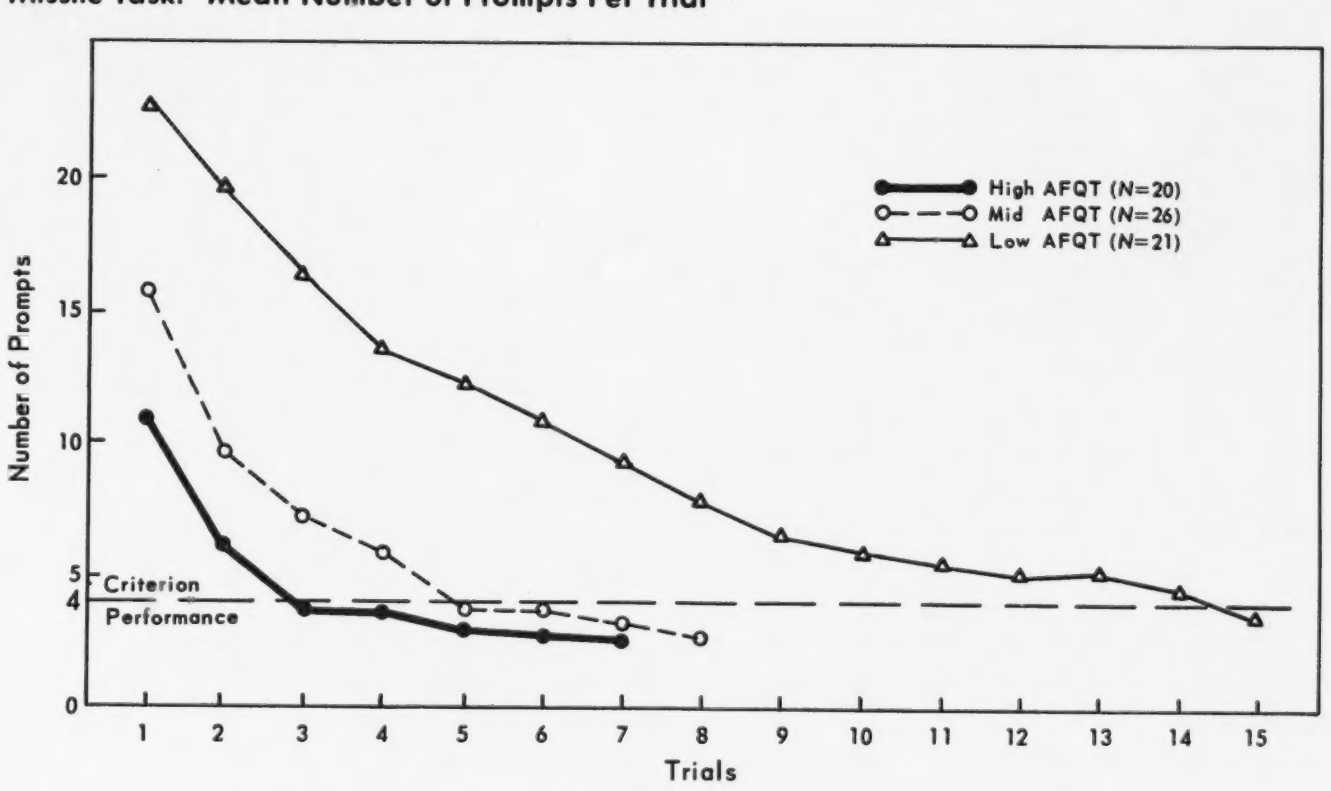

Figure 12

There are clearly differences in the mean number of prompts per trial required by the three aptitude groups. The High AFQT group mean bettered the criterion on the third trial and the Mid AFQT group bettered the criterion on the fifth trial. The Low AFQT group mean, however, did not surpass the

Table 14

Missile Task: Means and Standard Deviations of Trials-To-Criterion and Time-To-Criterion Scores

Aptitude Group	N	Trials-To-Criterion[a]		Time-To-Criterion[b]	
		Mean	Standard Deviation	Mean	Standard Deviation
High AFQT	20	3.3	1.2	11.3	5.6
Mid AFQT	26	5.0	1.7	18.4	6.8
Low AFQT	21	10.4	3.7	45.5[c]	18.5

[a] $F = 49.05$; $df = 2,64$; $p < .001$.
[b] $F = 51.00$; $df = 2,64$; $p < .001$.
[c] Five Low AFQT subjects did not attain the criterion of fewer than five prompts and were arbitrarily assigned scores based on 15 trials. Therefore, the mean and standard deviation for the Low AFQT group are underestimated.

criterion until the final trial (Trial 15). The mean number of prompts required to attain criterion performance or complete Trial 15 was 22.9 for the High AFQT group, 42.9 for the Mid AFQT group, and 133.0 for the Low AFQT group. These differences were very significant ($F = 40.81$; $df = 2,64$; $p < .001$).

Table 14 shows the mean number of trials and the mean amount of time in minutes required by each group to better the criterion of four or fewer prompts per trial. Five Low AFQT subjects failed to meet criterion and were arbitrarily assigned scores based on 15 trials. Thus, the means and standard deviations are underestimated for the Low AFQT. The low aptitude group required at least three times as many trials and four times as much time to attain criterion (or complete 15 trials) as did the high aptitude group, and at least twice as many trials and more than twice as much time as the middle aptitude group.

A comparison between high and middle aptitude groups showed that the High AFQT group required significantly fewer trials ($t = 3.78$, $p < .001$) and significantly less time ($t = 3.79$, $p < .001$) to attain criterion than did the Mid AFQT group.

Figure 13 presents the cumulative percentages of subjects in each aptitude group reaching criterion on each trial. Note that by Trial 5, 95% of the High AFQT group and 69% of the Mid AFQT group had bettered the criterion, but only 10% of the Low AFQT group had achieved criterion performance. After 15 trials, 24% of the Low AFQT group had not yet attained criterion proficiency. There was a definite overlap in performance among aptitude groups. Also, a substantial percentage of low aptitude subjects reached criterion in the same number of trials as some of the slower high aptitude subjects (29% by Trial 7).

Subjects who reached criterion and completed the task were given an additional post-criterion trial without benefit of the written checklist and with no prior knowledge that they would perform the task without the checklist. The mean number of prompts required to complete the 34-step sequence on the post-criterion trial were 12.5 for High AFQT, 12.0 for Mid AFQT, and 10.4 for Low AFQT.[1] The trend, although not significant ($F = 2.31$; $df = 2,59$; $p = NS$), was for the low aptitude subjects who attained criterion to require fewer prompts than the higher aptitude subjects when the checklist was no longer available. This finding was supported when the mean of difference scores between the final criterion trial (with checklist) and the post-criterion trial (without checklist) were compared. The means of difference scores were 10.4 for High AFQT, 9.7 for Mid AFQT, 7.4 for Low AFQT ($F = 3.83$; $df = 2,59$; $p < .05$). The low aptitude subjects evidently were unable to make as efficient use of the checklist as the higher aptitude subjects during training and had to rely more on other learning

[1] Low AFQT mean is based on 16 subjects, as the remainder failed to reach criterion and complete the task.

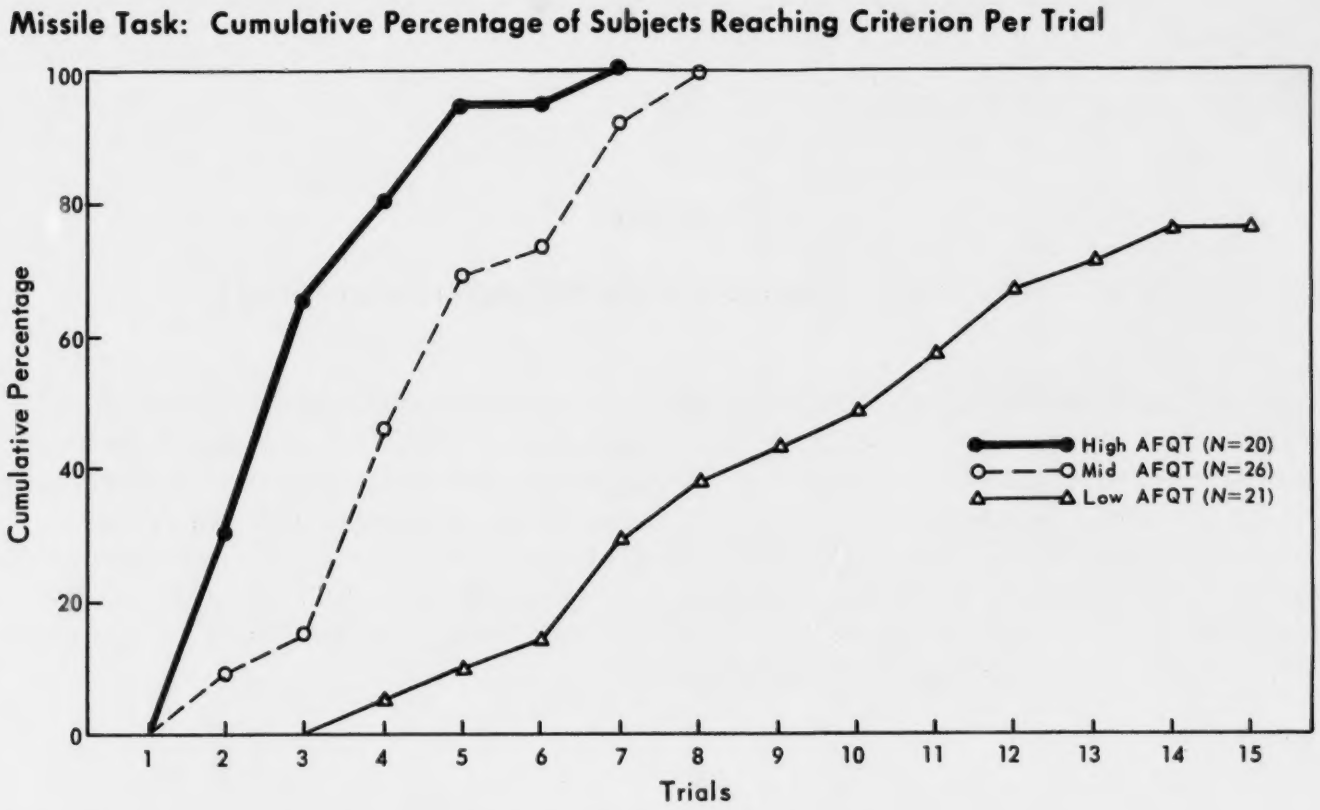

Figure 13

strategies (i.e., rote memory). This could account for their superior performance on the post-criterion trial.

SUMMARY

In summary, low aptitude subjects required six times as many prompts, three times as many trials, and at least four times as long as high aptitude subjects to reach criterion on the missile task. The middle aptitude subjects required approximately one-third as many prompts, one-half as many trials, and less than half as much time as the low aptitude subjects to attain criterion. Variability among trainee groups was inversely related to aptitude level with low aptitude subjects showing the greatest variability in performance. Apparently, lower aptitude subjects relied less on the checklist and more on other learning strategies than did the other subjects, as they showed less performance decrement than the other two groups on the post-criterion trial when the checklist was no longer available.

Chapter 6

MILITARY SYMBOLS AND PHONETIC ALPHABET

Military symbols and the international phonetic alphabet are examples of military tasks involving multiple discrimination. The Military Symbols Task requires learning to associate words with symbols, while the Phonetic Alphabet Task requires learning to associate letters of the alphabet with corresponding phonetic equivalents. Examples of other tasks of this nature include learning hand and arm signals, cooking times and temperatures for food, part names and weapon nomenclature, and color coding. These tasks represented an intermediate level of complexity in the task battery.

METHOD

Eighty subjects—25 High AFQT, 30 Mid AFQT, and 25 Low AFQT took part in the Military Symbols Task; and 74 subjects—21 High AFQT, 29 Mid AFQT, and 24 Low AFQT—participated in the Phonetic Alphabet Task. Pretest data indicated that subjects had no prior experience with the subject matter.

Military Symbols

This task consisted of learning 26 commonly used military map symbols. Each symbol appeared on a 5" x 8" study card with its appropriate name and an artist's representation of the thing, place, or event represented by the symbol. Figure 14 is an example of the study card used for the "artillery" symbol.

After a pretest to determine the subject's familiarity with the symbols, the subject was shown the 26 study cards, one at a time, by an instructor who identified each symbol and read the symbol name aloud. The subject was then given the study cards and instructed to learn them, as he would be tested on them shortly. Three minutes were allowed for the subject to study the 26 symbols.

At the conclusion of the three-minute study period, the cards were taken from the subject and he was given an answer sheet containing the symbols in scrambled order. The subject was instructed to identify each symbol by writing the appropriate symbol name in a blank space adjacent to each symbol (oral responses were accepted from those subjects who were unable to spell or write legibly). The instructor recorded correct responses as they were written (or given orally) on a separate record sheet. At the conclusion of the testing period, the instructor indicated the errors the subject had made and told him the correct responses. Trials were continued until two successive errorless trials were recorded (i.e., the subject had correctly named the 26 symbols on two successive trials) or until the subject had completed 12 trials.

Phonetic Alphabet

The Phonetic Alphabet Task consisted of learning the 26 international phonetic equivalents to the alphabet. All of the 26 letters and their corresponding

Sample Study Card for Military Symbols

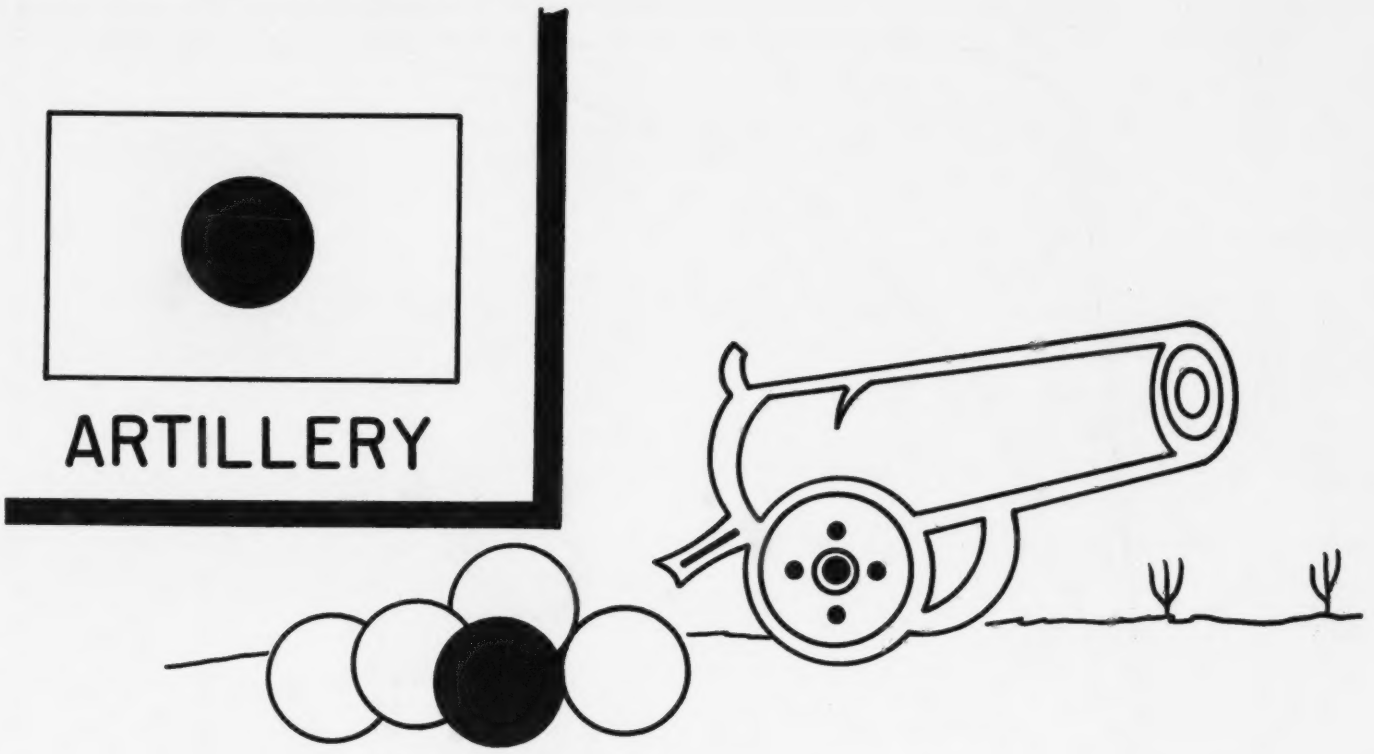

Figure 14

phonetic equivalents were printed on a single 8½" x 11" card in correct alphabetical sequence: A-ALFA, B-BRAVO, C-CHARLIE, etc.

The general procedure for the Phonetic Alphabet Task followed that outlined for the Military Symbols Task. After a pretest, the instructor read each letter and its appropriate phonetic equivalent aloud. The subject was then given the study card and allowed to study for three minutes.

After the study period, he was presented with an answer sheet containing the letters of the alphabet in correct alphabetical sequence. The subject was to respond with the correct phonetic equivalent. As in the Military Symbols Task, oral responses were accepted from those subjects unable to spell or write clearly. Errors were corrected by the instructor immediately following the test period. Trials were continued until the subject correctly responded with all 26 phonetic equivalents on two successive trials, or until he had completed eight trials.

RESULTS

The results for the Military Symbols and Phonetic Alphabet Tasks are presented separately. The second criterion trial served only as a test trial to assure that learning had in fact occurred; it was not included as a separate trial in the data analysis.

Military Symbols

The mean numbers of correct responses per trial for the Military Symbols Task are presented in Figure 15 for the three aptitude groups. Inasmuch as some subjects in each group attained criterion and completed the task in fewer trials than other members of the group, the N per trial was held constant by

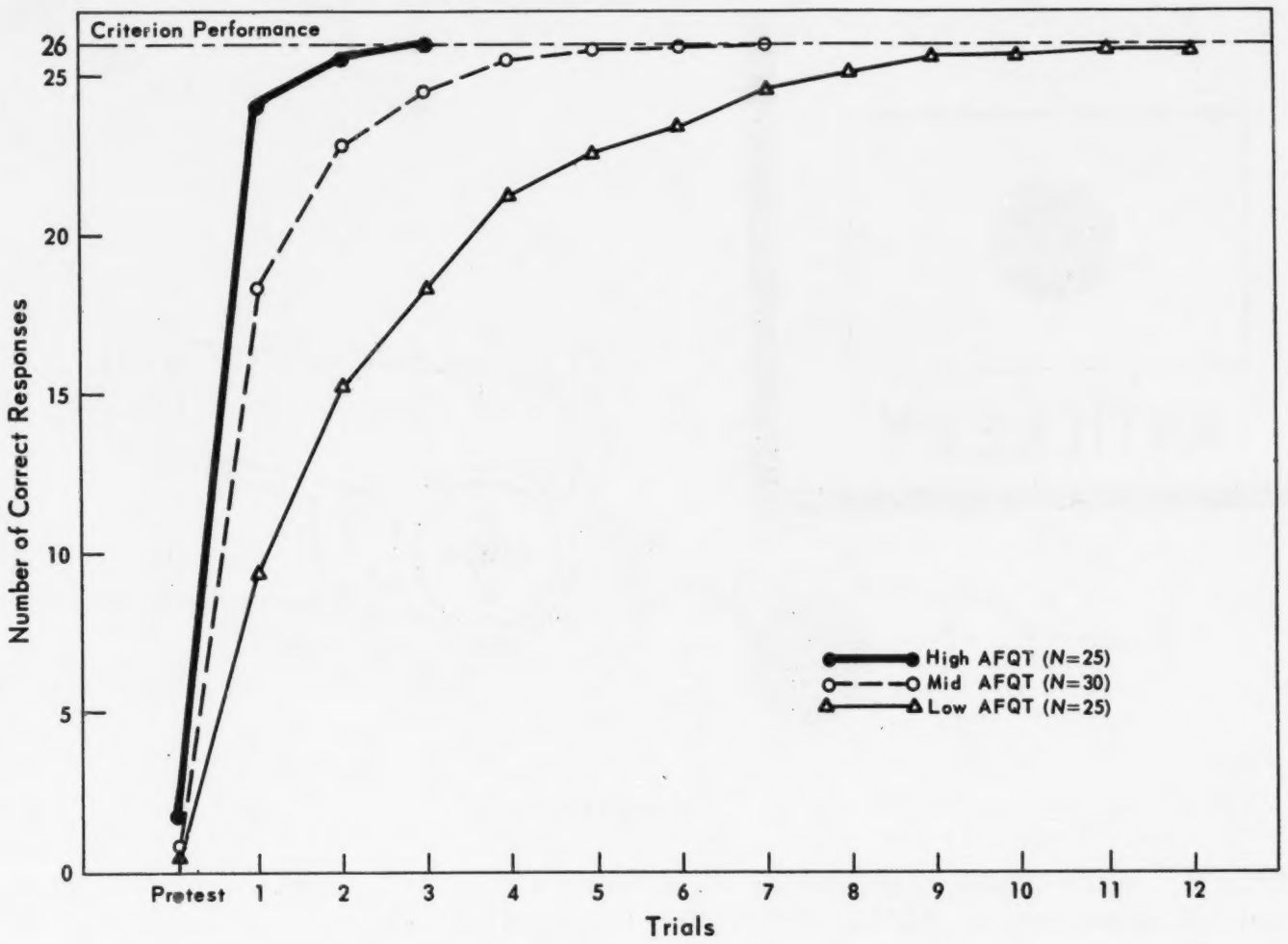

Figure 15

continuing to enter scores of 26 for those subjects who had reached criterion before the slowest group member.

As shown in Figure 15, every subject in the High AFQT group had attained criterion performance by the third trial. The slowest subjects in the Mid AFQT group required seven training trials to reach criterion, while not all Low AFQT subjects had completed the task by Trial 12.

Table 15

Military Symbols: Means and Standard Deviations of Trials-To-Criterion Scores

Aptitude Group	*N*	Mean[a]	Standard Deviation
High AFQT	25	1.7	.8
Mid AFQT	30	3.3	1.6
Low AFQT	25	6.2[b]	2.4[b]

[a] $F = 42.35$; $df = 2,77$; $p < .001$.

[b] Five Low AFQT subjects who did not attain the criterion of errorless performance were arbitrarily assigned scores based on 12 trials. Thus, the mean and standard deviation of the Low AFQT group are underestimated.

A comparison of Military Symbols pretest means indicated that the High AFQT group (pretest mean of 1.7) did significantly better on the pretest ($p < .05$) than did the Mid AFQT (pretest mean of .8) and the Low AFQT (pretest mean of .5) groups. These pretest differences probably reflect better ability on the part of high aptitude subjects to abstract, and to infer, the meaning of a symbol from its form. These pretest differences, although statistically significant, were hardly large enough to account for the subsequently observed differences in acquisition rate among groups noted in Figure 15.

Means and standard deviations of trials-to-criterion scores are presented in Table 15.

Five subjects in the Low AFQT group failed to meet criterion and were assigned scores based on 12 trials. The mean and standard deviation presented in Table 15 are thus underestimates of the performance of this group. It can be seen, however, that the Low AFQT group took about twice as many trials to attain criterion as the Mid AFQT group, and that the Mid AFQT group took about twice as many trials to reach criterion as the High AFQT group.

The cumulative percentage of subjects reaching criterion per trial presented in Figure 16 permits comparisons within groups as well as among groups. Note, for instance, that by Trial 3 all of the High AFQT subjects had reached criterion, while 63% of the Mid AFQT subjects and only 12% of the Low AFQT subjects had learned all of the symbols. Note also that the low aptitude group exhibited much greater variability than the other two groups in attaining the criterion. Almost half of the low aptitude subjects had learned the symbols by Trial 5, while at the other extreme, 21% of them had not learned the symbols by Trial 12 when training was stopped. The variability within the other two groups is much less pronounced.

Phonetic Alphabet

The mean number of correct responses per trial for the Phonetic Alphabet Task is presented in Figure 17 for the three aptitude groups. As in the Military Symbols Task data analysis, the N per group was held constant by entering scores of 26 for those subjects in each group completing the task before the slowest group member. These curves (Figure 17), when compared to those of the Military Symbols Task (Figure 15), indicate that learning rates for the two tasks were quite similar and that the Phonetic Alphabet Task was apparently relatively

Military Symbols: Cumulative Percentage of Subjects Reaching Criterion Per Trial

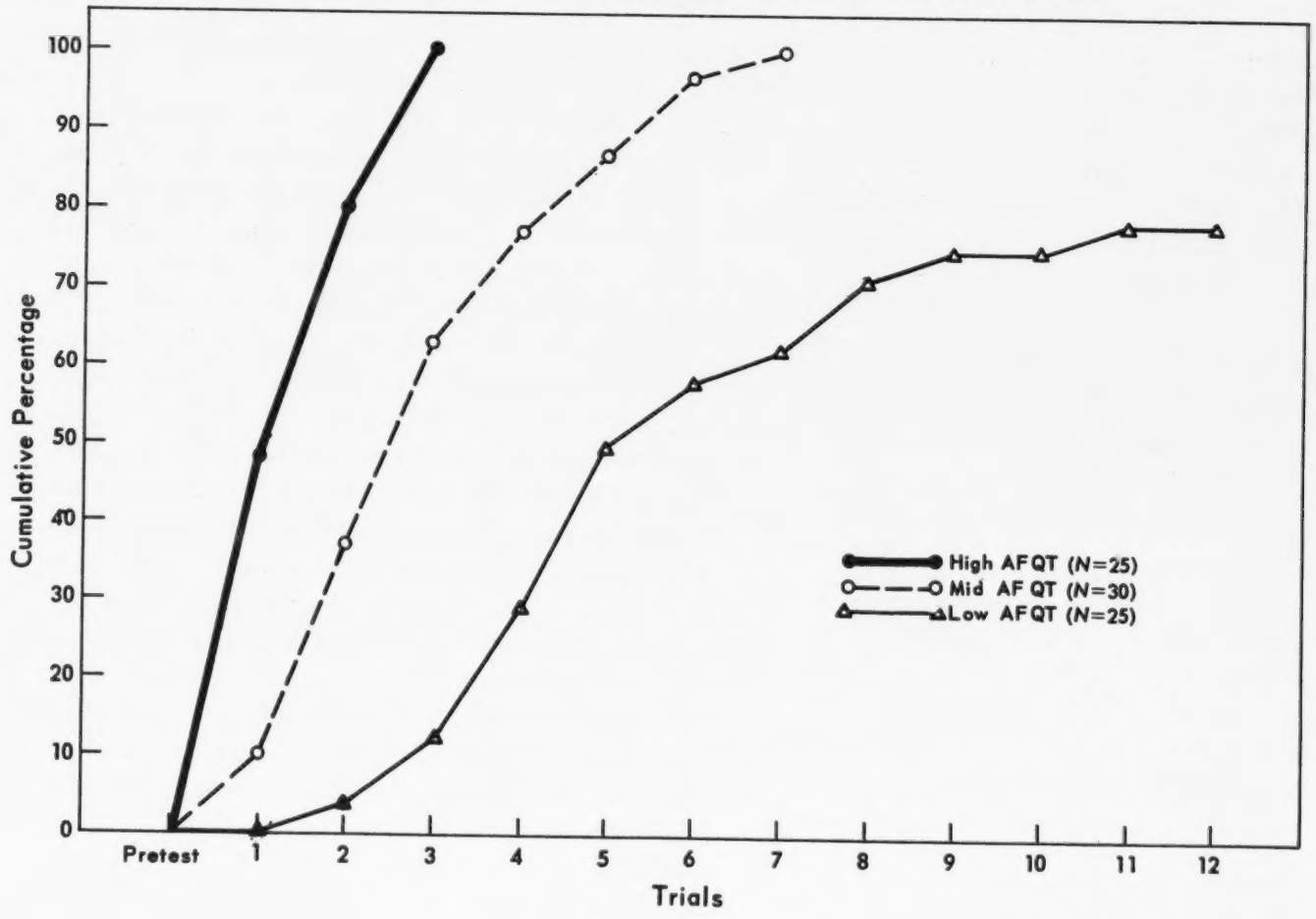

Figure 16

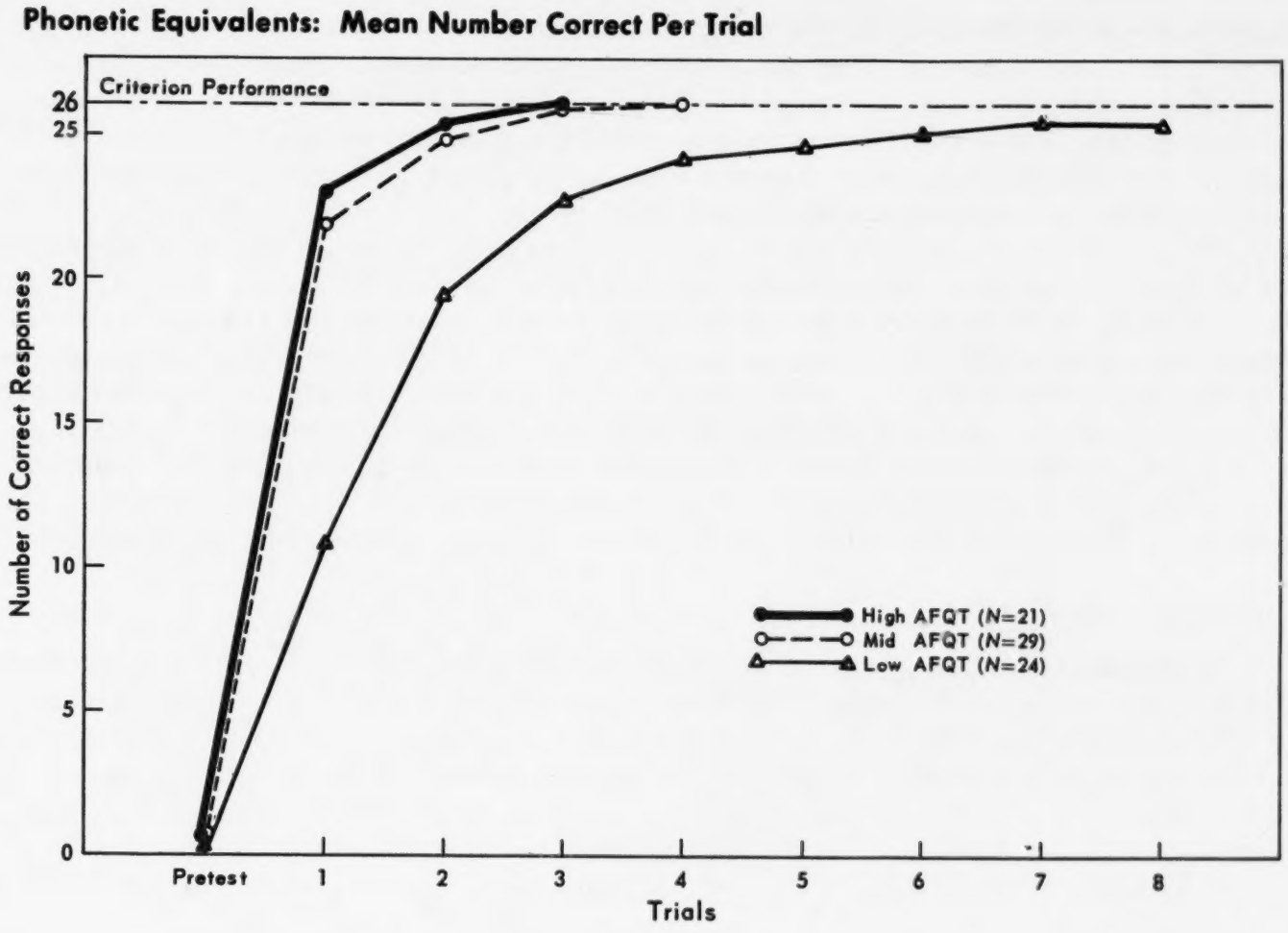

Figure 17

less difficult for the middle and low aptitude groups. Two important task differences that possibly had an effect were: (a) the additional cues provided by the matching of the alphabet letter and the first letter of the phonetic equivalent, and (b) the constant serial position of stimulus-response pairs throughout the Phonetic Alphabet Task. The High AFQT groups seemed not to be as susceptible to these task differences, as they appeared to perform both tasks with about equal facility.

A comparison of pretest means on the Phonetic Alphabet Task indicated no significant differences among groups. Table 16 contains the means and standard deviations of trials-to-criterion scores for the Phonetic Alphabet Task. Analysis of variance indicated significant differences among groups. Between-group comparisons indicated there were no significant differences between the high and middle aptitude groups, and further, that both of these groups learned in a significantly fewer number of trials than the low aptitude groups.

Table 16

Phonetic Alphabet: Means and Standard Deviations of Trials-To-Criterion Scores

Aptitude Group	*N*	Mean[a]	Standard Deviation
High AFQT	21	1.9	.8
Mid AFQT	29	2.1	.9
Low AFQT	24	4.0[b]	1.9[b]

[a] $F = 20.75$; $df = 2,71$; $p < .001$.

[b] One subject in the Low AFQT group did not attain errorless performance and was arbitrarily assigned a score based on eight trials. Therefore, the mean and standard deviation for this group are slightly underestimated.

The cumulative percentage of subjects reaching criterion per trial is presented in Figure 18. The curves are much alike for the high and middle aptitude groups, and both differ markedly from that of the low aptitude group. As in the Military Symbols

Task, all of the High AFQT subjects had attained criterion by the third trial. Almost all of the Mid AFQT subjects had also reached criterion by Trial 3, while less than half of the Low AFQT subjects had done so. Although not as pronounced as in the Military Symbols Task, wider variability is again evidenced within the Low AFQT group.

Phonetic Equivalents: Cumulative Percentage of Subjects Reaching Criterion Per Trial

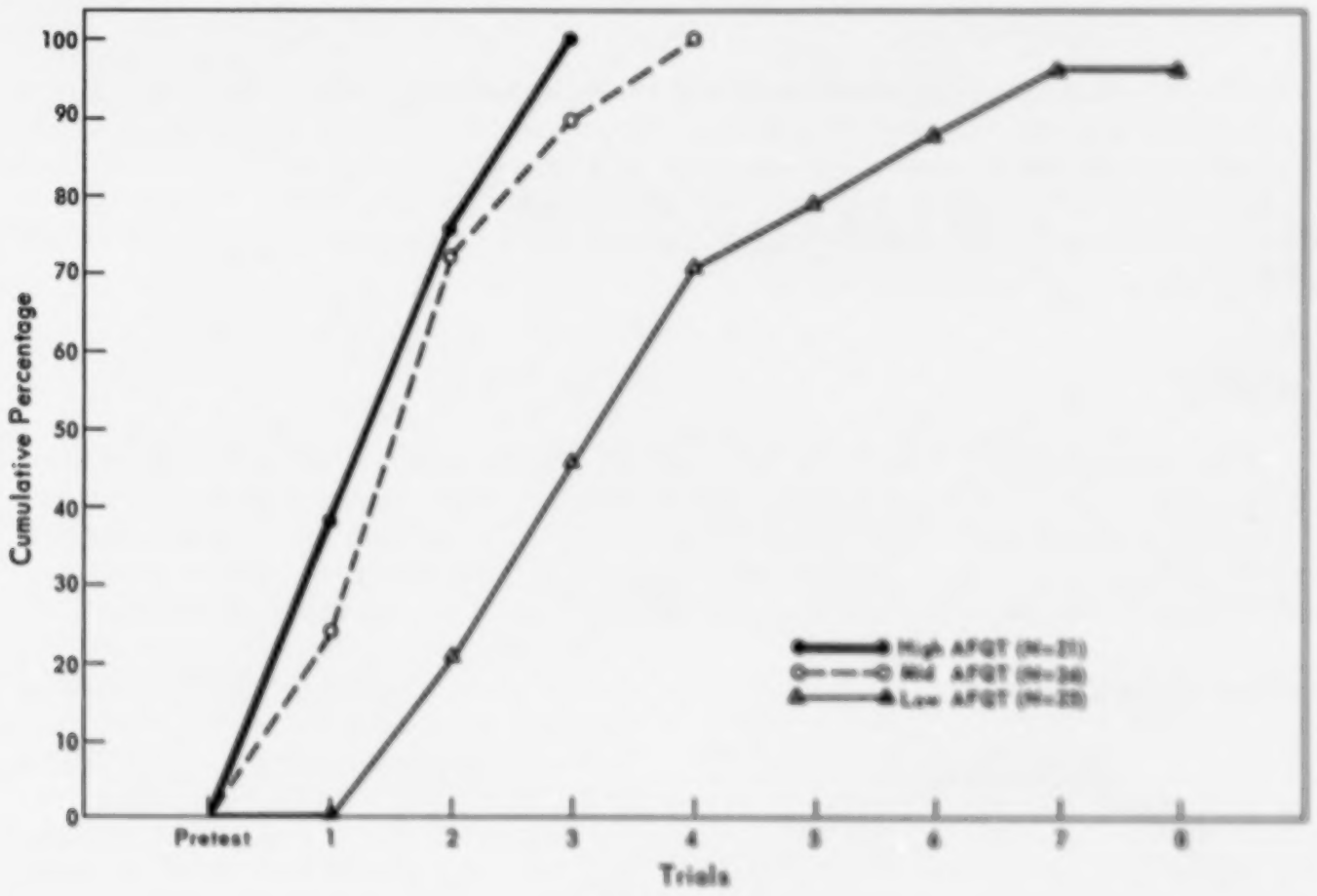

Figure 18

Chapter 7

COMBAT PLOTTING

The Combat Plotting Task involved learning and applying principles. Here, the recruit had to learn the concepts of range and bearing and apply them in an intersection problem to plot the position of a target. Similar tasks are common to the variety of target acquisition or plotting tasks of all combat MOSs. The Combat Plotting Task represents the highest level of complexity included in the task battery.

METHOD

Twenty-four High AFQT, 29 Mid AFQT, and 24 Low AFQT subjects participated in the Combat Plotting Task, which involved learning to plot the position of enemy aircraft from data describing the target's bearing and range relative to the subject's position. Instruction in plotting techniques was given using a coordinated audiotape/35mm slide program presented via closed-circuit TV.

Combat Plotting Board

Figure 19

Specifically, the instructional period consisted of (a) the definition of bearing, including examples, and practice on using the concept to determine direction from a given point; and (b) the definition of range and practice on determining distance from a given point. Finally, the subject practiced using both concepts to make plots of the position of enemy aircraft. A plotting board like that shown in Figure 19 was used by the subject for the practice problems. An instructor was present to provide help, direct practice, and answer questions throughout the instructional sequence.

At the end of training, subjects were required to make 10 plots on the plotting board. They were given the bearing, in degrees, and the range, in miles, of an enemy aircraft and were required to draw an "X" on the board at the point of intersection. During the testing periods, subjects were allowed seven seconds to make each plot. After each plot, the instructor provided immediate knowledge of results by indicating on the subject's plotting board the correct point of intersection using the plotting techniques previously shown. After each block of 10 plots the instructional sequence,

except for introductory material, was repeated. Training was continued until the trainee was able to make nine out of ten correct plots on two successive blocks (trials) or until he had undergone a total of 10 trials.

RESULTS

The mean correct plots per trial are presented in Figure 20 for the three aptitude groups. The second criterion trial was used only to assure that the trainee could perform the task reliably and was not used in the data analysis. The N per trial for each group was held constant by supplying criterion scores for those trainees reaching criterion before the slowest member of each group.

Combat Plotting: Mean Number of Correct Plots Per Trial

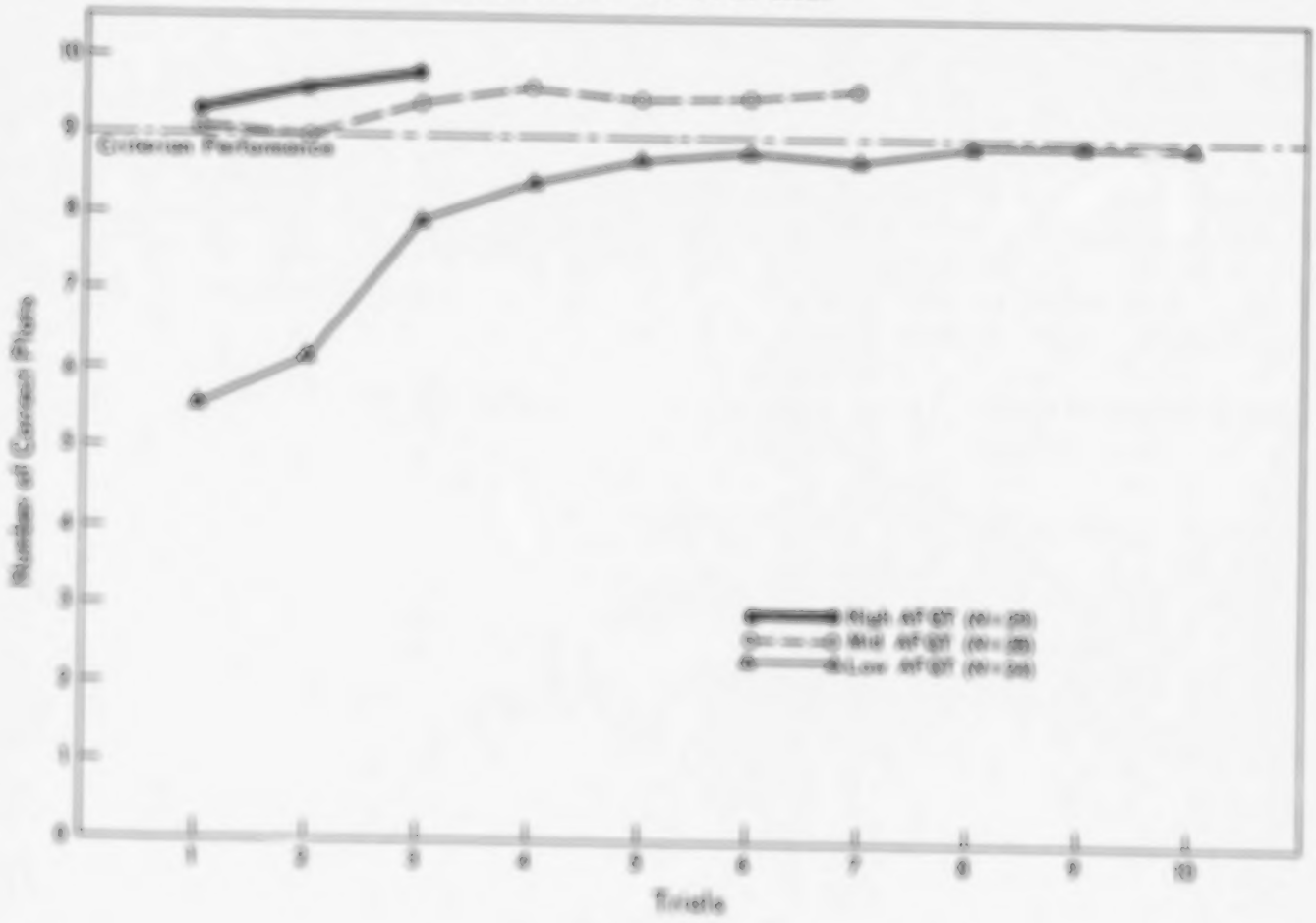

Figure 20

The means for the middle and high aptitude groups were above criterion on the very first test trial following instruction, although not all subjects in these two groups had attained criterion performance. The low aptitude group, however, needed additional training to approach criterion performance.

The means and standard deviations of the trials-to-criterion scores are presented in Table 17. Analysis of variance indicated the overall differences were highly significant; however, there was no significant difference between the high and middle aptitude groups. The differences between these two groups and the low aptitude group are quite large, even though six of the 24 Low AFQT subjects failed to meet criterion and their scores are heavily underestimated.

The cumulative percentage of trainees meeting criterion provides a picture of individual performance. It can be seen in Figure 21 that three-fourths of the

Table 17

Combat Plotting: Means and Standard Deviations of Trials-To-Criterion Scores

Aptitude Group	*N*	Mean[a]	Standard Deviation
High AFQT	24	1.3	.6
Mid AFQT	28	1.7	1.3
Low AFQT	24	5.2[b]	3.3[b]

[a] $F = 25.83$; $df = 2,73$; $p < .001$.

[b] Six Low AFQT subjects did not meet the criterion of nine out of 10 correct plots and were arbitrarily assigned scores based on 10 trials. Thus, the mean and standard deviation reported for the Low AFQT are underestimated.

subjects in the high aptitude group could perform the task after the initial presentation of the plotting instructions, while less than 10% of the low aptitude subjects were capable of criterion performance following the initial instructional sequence. After 10 trials of instruction and practice, one-fourth of the Low AFQT subjects still had not attained criterion performance. All but one of the middle aptitude subjects were able to make accurate plots by the third training trial, while the remaining subjects required seven trials.

SUMMARY

The high and middle aptitude groups had little trouble mastering the Combat Plotting Task. The low aptitude group required much more training time than the higher aptitude groups. Greater variability was also displayed by the low aptitude group in that a few subjects were able to master the plotting task early in training, while a substantial number failed to attain criterion performance within the 10 trials allotted for instruction and practice.

Combat Plotting: Cumulative Percentage of Subjects Reaching Criterion Per Trial

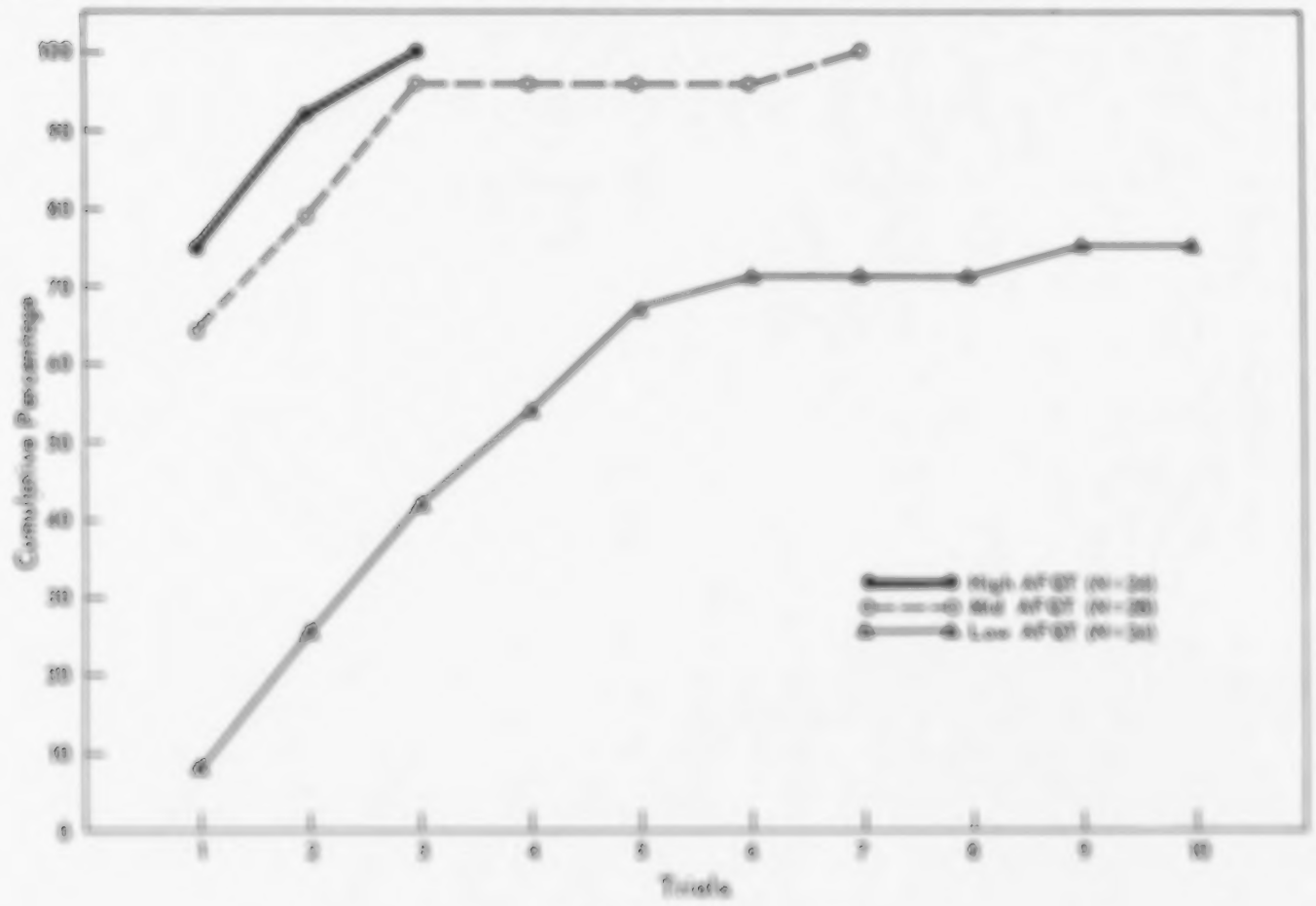

Figure 21

Chapter 8

SUMMARY DISCUSSION AND IMPLICATIONS OF FINDINGS

The objective of the work reported here was to determine the extent to which mental aptitude (as measured by the AFQT) is related to the acquisition of military skills and knowledges of the kinds required in combat and combat support MOSs.

Current technology of training provides little information useful to the Armed Forces for designing training programs to accommodate the entire spectrum of aptitude, and practically nothing is known specifically about the engineering of training for those in lower Category IV. If the military forces hope to develop training programs that will be effective for all trainees, a necessary first step is that of assessing the relationship of trainee aptitude to training performance. With the Armed Services currently taking some 22% of their enlisted accessions from the marginal manpower pool, the collection of such data was considered essential.

DISCUSSION OF FINDINGS

The sample of [illegible]3 Army recruits was selected to constitute three homogeneous non-overlapping aptitude groups. These three groups were consistently and highly different on a variety of measures, as summarized below.

Entry Level Characteristics

As elaborated in Chapter 2, the examination of both psychometric data (Army Classification Battery and Aptitude Area scores) and scholastic achievement (educational level completed, reading, arithmetic proficiency) showed the high aptitude subjects were decidedly superior to the low aptitude subjects, with middle aptitude groups scoring in an intermediate range. It was somewhat surprising to discover that so many of the low aptitude subjects had completed high school (61%). To the extent that high school graduation is based on academic achievement no higher than that indicated by the AFQT, reading, and arithmetic scores of the low aptitude sample, the data suggest that educational attainment as a variable for predicting performance will become of decreasing usefulness.

Laboratory Findings

Data were collected on a battery of training tasks selected to be representative of the skills and knowledges found in heavy density military jobs. The eight training tasks that composed the task battery ranged in complexity from relatively simple stimulus-response association and procedural learning tasks to the more complex learning of multiple-discrimination, and concepts and principles. Instructional methods and learning conditions were established, on a judgmental basis, to afford the lower aptitude recruit the best possible opportunity to learn without regard for cost or effort, or for efficiency for the middle and high aptitude groups.

The data in Chapters 3 through 7 indicated that large and consistent differences, related to aptitude, were found on seven measures employed to assess learning performance in the laboratory learning tasks. These measures included response time, trials- and time-to-criterion, prompts, number of correct responses per trial, and response variability. Low aptitude subjects displayed poorer performance than higher aptitude subjects on all these measures.

The finding that the aptitude groups differed in their response time scores in the monitoring tasks is not taken as having great practical significance in itself. However, if such relatively simple tasks show these differences, it may well be that the aptitude groups would be separated by greater time intervals on similar tasks requiring more complicated response patterns. The major significance of these findings is that high aptitude individuals are apparently able to make these kinds of perceptual motor responses faster than the lower groups. In field situations (putting weapons into action, monitoring, target detection, aircraft identification) where tasks are more complex, compounded by confusion, or overlaid by other tasks, such speed of response differences may well have important practical impact.

On the more complex training tasks, differences in training time required were of such magnitude (factors of 4 and 5 when comparing lows with highs) that they are interpreted as having considerable significance. The practical significance of these findings may loom largest in training men of low aptitude to perform such tasks as missile preparation (a long procedural task) and combat plotting (a complex task involving concepts and principles) under more realistic training conditions. The missile task employed here was only one-third as long as the actual missile checkout procedure from which it was adapted. Further, typical Army procedural training of this nature does not routinely provide the trainee with written checklists to follow. The Combat Plotting Task employed here required the trainee to learn only range and bearing, just two of the many variables involved in combat plotting and target acquisition.

A previous study (2) performed under operational conditions to assess the effects of increasing or decreasing training time on critical armor skills found a similar relationship between aptitude level and required training time. Among the several findings in that study relating to aptitude level and learning rate, it was found:

(1) For each level of aptitude in general, as amount of training time increased the percentage of test items answered correctly increased correspondingly.

(2) Except in two of 18 skill areas, high aptitude trainees were superior to medium aptitude trainees and these were superior to low aptitude trainees at every level of instruction time (half, full, twice, and three times standard period).

(3) For most of the skills areas, high aptitude trainees who received instruction for half the standard period were superior or equal to low aptitude trainees who received instruction for three times the standard period (1:6 ratio) and to medium aptitude trainees who received training for twice the standard period (1:4 ratio).

(4) In four major areas (communications, gunnery, driving and maintenance, and tactics), the greatest disparity among aptitude groups was shown in the gunnery area where, even after doubling and tripling the instruction time, the low aptitude group failed to acquire anything approaching an adequate degree of skill.

The results of a study under Work Unit BASICTRAIN, done in 1956 (1), indicated that high aptitude trainees generally did as well after four weeks of

training as they did after eight weeks. Middle and low aptitude trainees did better after eight weeks of training than they did after four.

It is thus highly conceivable that under operational, rather than laboratory, training conditions, the development of proficiency in performing the more complex tasks included in the task battery might prove to require more training time for low aptitude trainees than the factors of 4 and 5 found in this study indicate.

The tasks that provided measures of the amount of prompting and instructional guidance required to attain criterion performance yielded results which are of considerable import. Here, much like the learning time measures, comparison of lows with highs showed difference factors of 5 and 6. This finding has implications for the amount of guidance and instructor intervention needed by men of differing aptitude levels. While the following observations go beyond the data, low aptitude trainees probably require frequent access to an instructor, and probably require considerable guidance and coaching. This is true whether the "instructor" is human, a self-teaching program, or a computer. In conventional instructor-based training, these trainees probably are penalized severely as class size becomes large.

Although the groups selected were highly homogeneous on AFQT, the performance of these groups on the learning tasks was not equally homogeneous. The high aptitude group showed the least variability, and all of them reached criterion performance level on every task. The middle aptitude group displayed slightly more variability; on only two tasks did a few of its subjects fail to reach criterion. Variability of learning performance was notably greater in the low aptitude group. On almost every task a few low aptitude subjects performed as well as the middle and high groups; similarly on almost every task some low aptitude subjects failed to reach criterion, and the remainder were scattered over a wide range of performance.

The man identified as "low CAT IV" is not necessarily a slow learner on all tasks. Men who are of marginal aptitude on the AFQT are not qualitatively alike—they constitute a heterogeneous group. Apart from low general aptitude, a low AFQT score can arise from many factors unrelated to later learning performance: language difficulty; unfamiliarity with testing procedures; and motivation, mood, and physical condition at the time of testing. An important problem to be solved in military training lies in the differential sorting of low aptitude personnel. There is a need for devising ways to identify the faster learners and their areas of promise among those who enter service labeled as low CAT IVs. The design of this study, which was directed to the comparison of the performance of extreme aptitude groups on a large number of different learning tasks, precluded any analysis of individual consistency of behavior.

One remaining aspect of these findings deserves discussion at this point—the interaction of aptitude effects with training trials. In most instances, the data showed large differences among aptitude groups on the early trials, with this difference decreasing systematically over trials. In some tasks all groups eventually reached the same level of performance; in other tasks they appeared to reach different asymptotes. Apparently, subjects exhibited a differential ability to profit from initial instruction. High, and in many cases middle, aptitude subjects were able to master the material in just a few training trials.

One can speculate that the higher aptitude groups were just brighter and could therefore assimilate and process information faster, that they had learned how to learn and thus had a set conducive to rapid learning, or that they were able to adapt better to novel situations (recall that the lab battery consisted of a number of short, unrelated, discrete tasks, no one of which consumed more than

an hour and a half). As an individual progressed through the task battery, he was faced with a number of novel situations. It could be hypothesized that rather than reflecting differences in aptitude or basic ability to learn, these observed differences were in large part reflecting nothing more than simple adaptability to novel situations. This hardly seems tenable, however, in view of the consistency of the lab findings with performance on the various other measures (witness the performance of our subjects in BCT with its repetitive, by-the-numbers approach to a long sequence of redundant training).

BCT Performance Data

As the detailed presentation of Chapter 2 indicated, these data, reflecting the performance of the three aptitude groups in the Army's eight-week BCT cycle, showed the same general effects.

ATT 21-2. This composite measure of training test performance, the Army's own measure of the trainee's mastery of a variety of fundamental military knowledges and skills, was administered to the sample under Army auspices. On the whole, the pattern remained unchanged. Whether the material was cognitive or primarily motor, high aptitude trainees were superior to middle aptitude trainees, who in turn surpassed the lows. Here, as in the lab tasks, the middles approached the highs.

Leader Prep Peer Ratings. These ratings, reflecting the judgment of an individual's peers concerning his potential as an NCO, were striking. Whereas only a few of the low aptitude group received ratings that met the screening standard for attending Leadership Prep School, one-fourth of the middles and more than half of the high aptitude trainees did so.

Consistency of Findings

The general pattern of these findings (across a variety of measures sampling performance upon entry into the Army) is one of striking consistency on the task battery and at the end of BCT. Such large and consistent aptitude effects have not been reported in the technical literature heretofore, probably because the typical study of aptitude effects has varied aptitude over a limited range only. The present study, in order to assess performance over the entire meaningful range of aptitude for military training, selected samples of subjects so that rather pure groups representing high, middle, and low ranges of aptitude could be studied.

The consistency of these findings is all the more striking considering the number and variety of subjects that were involved in the study. Rather than being based on the performance of fixed and possibly unique groups of subjects on whom many repeated measures were taken, these data are based on the performance of many different subjects who underwent many different combinations of tasks. These data reflect the performance of a variety of subjects reflecting the three levels of aptitude.

The data could not be analyzed to determine whether task complexity itself relates to performance. Although the eight laboratory tasks were selected to differ in complexity, no attempt was made to scale them along a dimension. Thus, although there is general agreement that Military Symbols (multiple discrimination) is more complex than Rifle Disassembly (motor procedure), an estimate cannot be made on how much more complex it actually is; their relative positions on a quantitative scale of complexity cannot be determined.

Further, though the tasks were ordered as to complexity, task difficulty was not controlled. Thus, even though Missile Prep was less complex than Military Symbols, it was much more difficult to learn because of its length.

It is reasonable to hypothesize that lower aptitude subjects would have less and less learning success as task complexity increases. These data do not allow the test of such a hypothesis, but it is possible to say that, regardless of task complexity, mental aptitude is strongly related to performance.

CONCLUSIONS OF THE STUDY

The laboratory findings discussed in this chapter, in conjunction with the entry level and BCT findings discussed in Chapter 2 and summarized above, lead to the following conclusions:

(1) Mental aptitude, as measured by performance on the Armed Forces Qualification Test, relates consistently to a variety of important psychometric and operational criteria, which include:

(a) Performance on the Army's psychometric tests for classification and assignment.

(b) Scholastic achievement as indicated by scores on reading and arithmetic tests and by school grade level completed.

(c) Army basic training performance—as shown on a wide variety of tests of knowledges and skills in cognitive and motor subject matter areas—and a measure of leadership potential.

(2) Learning performance is directly related to aptitude level. This relationship holds across a variety of training tasks which differ in complexity. This relationship is demonstrated by an array of response measures which show that:

(a) In some tasks aptitude groups differ in rate of learning only.

(b) In some tasks aptitude groups differ both in rate of learning and in final level of performance.

(c) In simple response tasks aptitude groups differ in both speed and accuracy of response.

(d) The time required to train low aptitude recruits and high aptitude recruits to comparable levels differs substantially.

(e) The learning performance of middle aptitude groups is more like that of high aptitude groups than it is of low aptitude groups.

(f) Performance variability relates inversely to aptitude level. Not all recruits labeled low aptitude are slow learners on all tasks—on each task, a few show performance typical of the middle and high aptitude groups.

(g) The requirement for instructor guidance and prompting is related inversely to aptitude level.

The relationship of aptitude to the aforementioned measures is a consistent and powerful one with important implications for the efficient conduct of training. High and middle aptitude groups generally out-perform low aptitude groups by a wide margin. These findings, considered in the light of related studies, imply that the efficient training of men at all levels of aptitude will depend upon (a) the recognition of individual differences in aptitude, and (b) the design of instructional programs that are compatible with individual differences in learning rate and final performance capability.

IMPLICATIONS FOR MILITARY TRAINING

With Project 100,000 under way, all services are accepting large numbers of low CAT IV men into their current training programs. Data furnished by the Assistant Secretary of Defense (Manpower), as of February 1968, indicate that (a) the average grade level of low CAT IVs' reading ability is 6.2 years, (b) the percentage of low aptitude trainees requiring extra help in order to graduate from basic training is running approximately two to three times that of the other groups combined, and (c) attrition rates in advanced training are uniformly higher for low CAT IVs, running as high as 33% in some specialties.

In a recent SPECTRUM study, Army Training Center instruction in a combat support MOS was surveyed. Findings verified the presence of serious problems affecting training in combat support courses, many of them resulting from the continuing attempt to train all men, whatever their abilities, in a single instructional mold. The training system and its instructors are being strained by the attempt to accommodate men ranging in aptitude from the third grade to college level (from low CAT IV to high CAT I). The present structure and methodology are not serving either the slow or fast student well. High verbal and technical emphasis works against the soldier of low ability, but the slow, repetitive rate of presentation and lack of challenge discourage the fast learner. These data showed that failure rate in combat support training was inversely related to aptitude level.

A large number of studies reported in the educational literature bear out the relationship between IQ and school achievement (7). This literature also provides ample evidence that different students can progress at widely differing rates and achieve differing levels of final proficiency.

The well-aired issues of homogeneous grouping and the multitrack curriculum represent classical approaches to solving the problem of lockstep instruction by providing for individual differences.

What may be the largest and fastest moving area of research in public education today is that concerned with the individualization of instruction. Programed Instruction, Computer-Assisted Instruction, Individually Prescribed Instruction—all approaches to the individualization of instruction—are predicated on the existence of differential abilities to profit from instruction. Much valuable information is being generated which can and should be adapted to the solution of Army training problems.

Under Project 100,000 a wide variety of training is being designed, reengineered, or in some fashion modified to accommodate a wider range of student aptitudes. All Services are engaged in reviewing and modifying selected courses of training toward the goal of reducing learning difficulties for Category IV men. Across the Services a total of 37 such courses have been selected as "pilot" courses for study and modification.

Unfortunately, training technology does not specify how to go about this; it is not known which training strategies are most appropriate for which aptitude levels. However, early results reported from four or five Army courses being modified specifically for low CAT IVs indicate that these trainees are helped considerably when the training is geared to their level to ensure their assimilation of the material.

Another DoD program, Project TRANSITION, is now concerned with the retraining and utilization of men returning to civilian life. In this project, men who are about to be discharged are being provided job training and counseling. Priority is being given to men with low school achievement and to those who

have had no opportunity to acquire a civilian-related skill in service. Project TRANSITION's training and counseling are not restricted to men who enter military service under Project 100,000, but TRANSITION is a primary source of benefits for these men. The training problem of TRANSITION, like that of 100,000, would seem to make the accommodation of training to aptitude differences a matter of high priority at this time.

Considering the previous research, the experience to date of Project 100,000, and the pattern of findings reported from the present study, there can be no doubt that trainee aptitude is a potent variable that must be recognized in the conduct of military training. But trainee aptitude differences account for only part of the picture. The findings of studies of instructional method, the results reported from redesigned Project 100,000 courses, the current findings of SPECTRUM I, and the expanding literature on the individualization of instruction indicate that instructional method is likewise a potent factor. It is clear that no single instructional method is effective across all aptitude levels, and that individuals of differing aptitude levels require instructional methods that match their aptitude and, of course, motivation and experience. The college graduate and the low CAT IV simply cannot be reached by the same instructional vehicle. However, these same studies confirm the meagerness of current knowledge on how to go about designing appropriate training strategies for the various levels of aptitude. This is a serious gap in the technology of training and education.

Planned projections of the military training population for an indefinite period indicate that the range of aptitude will not decrease. Low CAT IVs will continue to be accepted indefinitely, and graduate students are to be inducted rather than exempted from service. Thus, the Army will be receiving approximately 25% of its enlisted accessions from the low CAT IV level at the same time that it significantly increases its input from the high CAT I level (by a yet unknown factor). It is not impossible to foresee a period of time in which more of the Army's recruits would be taken from the two extremes than from the middle range of aptitude. Indeed, the need for developing information to fill the gap mentioned above, information about the design of training strategies appropriate for varying levels of aptitude, appears to be a research area of primary importance.

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13. ABSTRACT

To assess the effects of wide differences in aptitude on the acquisition of military knowledge and skills, a sample of 180 Army recruits was divided into three maximally distant aptitude groups on the basis of their AFQT scores: High aptitude, AFQT 90-99; Middle aptitude, AFQT 40-65; Low aptitude, AFQT 10-35. Each recruit was individually trained to a performance criterion in differing combinations of a battery of eight tasks representative of Army training. A variety of supplementary psychometric, scholastic achievement, and MOS attainment data were analyzed. The results were consistent in demonstrating large differences related to aptitude. As groups, high aptitude individuals excelled, low aptitude individuals did poorly, and middle aptitude groups fell in an intermediate range on all measures.

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10 CG US ARMY FORCES SOUTHERN COMD ATTN SCARCD APO 09834 NY
2 CG US ARMY EUROPE APO 09403 NY ATTN OPNS DIV
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1 CG US ARMY AD COMD ENT AFB ATTN ADGCB
6 CG 1ST ARMY FT GEORGE G MEADE
1 CG 3RD US ARMY FT MCPHERSON GA
1 CG FOURTH ARMY FT SAM HOUSTON ATTN G3
2 CG FIFTH ARMY FT SHERIDAN ATTN ALFGC TNG
1 CG EUSA ATTN AG-AC APO 96301 SAN FRAN
1 DIR HEL APG MD
1 CG USA CDC EXPERIMENTATION COMD FT ORD
2 ENGNR PSYCHOL LAB PIONEERING RES DIV ARMY NATICK LABS NATICK MASS
1 TECH LIB ARMY NATICK LABS NATICK MASS
1 CO USA CDC INST OF LAND CBT FT BELVOIR
1 REDSTONE SCIENTIFIC INFO CTR US ARMY MSL COMD ATTN CHF DOC SEC ALA
1 CO USAPA MBLTY DET TOBYHANNA ARMY DEPOT
1 CG ARMY ELEC PG FT HUACHUCA ATTN TECH LIB
12 CO 1ST AIR DEF GUIDED MSL BRGD TNG FT BLISS
1 SIXTH U S ARMY LIB DEPOT BLDG N 13 14 PRES OF SAN
1 PLANS OFFICER PSYCH HDQTRES USACDCEC FORT ORD
5 CG FT ORD ATTN G3 TNG DIV
1 DIR WALTER REED ARMY INST OF RES WALTER REED ARMY MED CTR
2 DIR WRAIR WALTER REED ARMY MED CTR ATTN NEUROPSYCHIAT DIV
1 CO HQ ARMY ENLISTED EVAL CTR FT BENJ HARRISON
1 DPTY FOR BIOASTRONAUT PG AIR PG CTR EGLIN AFB
1 CO USA MOBILITY EQUIP R&D CTR ATTN TECH DOC CTR FT. BELVOIR
1 CO FRANKFORD ARSNL ATTN SMUFA-N6400/202-4
1 CG 5TH RGN USARADCOM ATTN G3 TNG GUNTER AFB ALA
3 6TH RGN USARADCOM FT BAKER
1 4TH ARMY MSL COMD AIR TRANSPORTABLE SAN FRAN
1 DIR ARMY BD FOR AVN ACCIDENT RES FT RUCKER
2 CO PICATINNY ARSNL DOVER N J ATTN SUMPA VCI
1 DEF SUPPLY AGY CAMERON STATION ATTN LIB
1 CO ARMY CBT DEVEL COMD FT BENJ HARRISON ATTN ADJ GEN AGY
1 REF M MS IS NASA ALA
1 CBT OPNS RES GP CDC FT BELVOIR ATTN SR OPRS ANLS HUMAN FACTORS
1 CO ARMY CDC INF AGY FT BENNING
1 CO ARMY CDC ARMOR AGY FT KNOX
1 EVAL DIV OAO ARMY SIG CTR & SCH FT MONMOUTH
1 CO US ARMY CDC AVN AGCY FT RUCKER
1 CHF CURRICULUM BR RESIDENT INSTR DEPT ARMY LOGISTICS MANGT CTR FT LEE
2 CIVLN PERS OFCR US ARMY SPT CTR ST LOUIS ATTN EMPLOYEE DEVEL OFCR
3 LIB ARMY WAR COLL CARLISLE BKS
1 COMDT COMD & GEN STAFF CO FT LEAVENWORTH ATTN ARCHIVES
1 DIR OF MILIT PSYCHOL & LDRSHP US MILIT ACAD WEST POINT
1 US MILIT ACAD WEST POINT ATTN LIB
1 COMDT ARMY AVN SCH FT RUCKER ATTN SCH LIB
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3 DIR OF INSTR ARMOR SCH FT KNOX
1 COMDT ARMY ARMOR SCH FT KNOX ATTN WEAPONS DEPT
1 COMDT ARMY CHAPLAIN SCH FT HAMILTON
1 COMDT ARMY CHEM CORPS SCH FT MCCLELLAN ATTN EDUC ADV
1 ARMY FINANCE SCH FT BENJ HARRISON
4 COMDT ARMY ADJ GEN SCH FT BENJ HARRISON ATTN EDUC ADV
1 EDUC ADV USAIS ATTN AJIIS-H FT BENNING
1 DIR OF INSTR USAIS ATTN AJIIS-D-EPRD FT BENNING
1 HQ US ARMY ADJ GEN SCH FT BENJ HARRISON ATT COMDT
1 LIB ARMY QM SCH FT LEE
1 COMDT ARMY QM SCH FT LEE ATTN EDUC ADV
1 COMDT ARMY TRANS SCH FT EUSTIS ATTN EDUC ADV
1 CO USA SEC AGY TNG CTR & SCH ATTN IATEV RSCH ADV FT DEVENS
1 COMDT ARMY MILIT POLICE SCH FT GORDON ATTN DIR OF INSTR
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1 COMDT USA AD SCH FT BLISS
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4 CG ARMY ARTY & MSL CTR FT SILL ATTN AVN OFFR
1 COMDT ARMY DEF INTEL SCH ATTN SI&AS DEPT
1 COMDT ARMED FORCES STAFF COLL NORFOLK
1 COMDT ARMY SIG SCH FT MONMOUTH ATTN EDUC COORD
1 COMDT JUDGE ADVOCATE GENERALS SCH U OF VA
1 DPTY COMDT USA AVN SCH ELEMENT GA
1 DPTY ASST COMDT USA AVN SCH ELEMENT GA
1 USA AVN SCH ELEMENT OFC OF DIR OF INSTR ATTN EDUC ADV GA
1 EDUC CONSLT ARMY MILIT POLICE SCH FT GORDON
6 COMDT ARMY ENGNR SCH FT BELVOIR ATTN AIBBES-SY
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1 CHF POLICY & TNG LIT DIV ARMY ARMOR SCH FT KNOX
1 COMDT ARMY AVN SCH FT RUCKER ATTN EDUC ADV
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1 DIR OF MILIT INSTR US MILIT ACAD WEST POINT
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1 COMDT US ARMY INTEL SCH FT HOLABIRD
1 COMDT ARMY QM SCH OFC DIR OF NONRESID ACTVY FT LEE ATTN TNG MEDIA DIV
2 DIR BRGD & BN OPNS DEPT USAIS FT BENNING
1 DIR COMM ELEC USAIS FT BENNING
1 DIR ABN-AIR MOBILITY DEPT USAIS FT BENNING
1 CG US ARMY SIGNAL CTR & SCH ATTN SIGOTL-3 (COBET II)
1 SECY OF ARMY, PENTAGON
1 OCS-PERS DA ATTN CHF C&S DIV
1 DIR OF PERS STUDIES & RES ODCSPER DA ATTN BG WALLACE L CLEMENT
2 AGS FOR FORCE DEVEL DA ATTN CHF TNG DIV
1 CG USA MAT COMD ATTN AMCRD-TE
1 CHF OF ENGNRS DA ATTN ENGTE-T
1 HQ ARMY MAT COMD R&D DRCTE ATTN AMCRD-RC
1 US ARMY BEHAVIORAL SCI RES LAB WASH, D.C. ATTN: CRD-AR
1 OPO PERS MGT DEV OFC ATTN MOS SEC (NEW EQUIP) OPOMO
1 ARMY PROVOST MARSHAL GEN
1 DIR CIVIL AFFAIRS DRCTE ODCSOPS
1 OFC RESERVE COMPON DA
2 CHF ARMY SECUR AGY ARLINGTON HALL STA ATTN AC OF S G1
50 ADMIN DDC ATTN: TCA (HEALY) CAMERON STA ALEX., VA. 22314
1 CO US ARMY MED RES LAB FT KNOX
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2 CG ARMY MED R&D COMD ATTN MEDDH-SR
1 U S ARMY BEHAVIORAL SCI RES LAB WASH, D.C. ATTN CRD-AIC
1 COMDT ARMY CBT SURVEIL SCH FT HUACHUCA ATTN ATSUR S3
2 TNG & DEVEL DIV ODCS-PERS
1 CO US ARMY MAT COMD WASH D.C. ATTN: AMCPT-CM ROBT DETIENNE
1 PRES ARMY MAINT BD FT KNOX
1 DPTY PRES ARMY MAT COMD BD ABERDEEN PG
1 CO ARMY CBT DEVEL COMD MILIT POLICE AGY FT GORDON
1 US ARMY ARCTIC TEST CTR R & D OFFICE SEATTLE
2 CG 4TH ARMORED DIV APO 09326 NY
1 CO 3D ARMORED CAV REGT APO 09034 NY
1 CO 14TH ARMORED CAV REGT APO 09026 NY
2 CG ARMY ARMOR & ARTY FIRING CTR FT STEWART ATTN AC OF S TNG OFCR
10 1ST INF DIV 1ST MED TANK BN 63D ARMOR FT RILEY
1 3D INF DIV 1ST BN 64TH ARMOR APO 09036 NY
8 8TH INF DIV 2D BN 68TH ARMOR APO 09034 NY
1 CO COMPANY A 3D BN 32D ARMOR 3D ARMORED DIV (SPEARHEAD) APO 09039 NY
1 CO 3D MED TANK BN 37TH ARMOR APO 09066 NY
2 CO 2D BN 34TH ARMOR APO 96266 SAN FRAN
1 CALIF NG 40TH ARMORED DIV LOS ANGELES ATTN AC OF SG3
1 55TH COMD HQ DIV ARMY NG JACKSONVILLE FLA
1 CG HQ 27TH ARMORED DIV NY AIR NG SYRACUSE
1 TEXAS NG 49TH ARMORED DIV DALLAS
1 CG ARMY ARMOR CTR FT KNOX ATTN G3 AIBKGT
2 CG 1ST INF DIV ATTN G3 APO 96345 SAN FRAN
1 CG 3RD INF DIV ATTN G3 NY
3 CG 4TH INF DIV ATTN G3 APO 96262 SAN FRAN
1 CG 7TH INF DIV ATTN G2 APO 96207 SAN FRAN
1 CG 8TH INF DIV ATTN G2 APO 09111 NY
1 CG 5TH INF DIV (MECH) FT CARSON
5 CG 24TH INF DIV ATTN G3 FT RILEY
3 CG 82D ABN INF DIV FT BRAGG ATTN G3
1 CO 197TH INF BRGD FT BENNING ATTN S3
1 CO 1ST BN (REINF) 3D INF (THE OLD GUARD) FT MYER
7 CO 3D BN 6TH INF REGT APO 09742 NY
1 CO 171ST INF BRGD APO 98731 SEATTLE
3 CG 25TH INF DIV APO 96225 SAN FRAN
1 CO 3D BN 39TH INF APO 09029 NY
1 CO 2ND BN 15TH INF NY ATTN S 3
4 CO 1ST BN (MECH) 52D INF 1ST ARMORED DIV (OLD IRONSIDES) FT HOOD
2 4TH BN (MECH) 54TH INF FT KNOX
1 CO ARMY PARTIC GP NAV TNG DEVICE CTR PT WASHINGTON ATTN CODE 01A
2 CONSOL RES GP 7TH PSYOP GP APO 96248 SAN FRAN
2 DA OFC OF ASST CHF OF STAFF FOR COMM-ELCT ATTN CETS-6 WASH
1 CG MILIT DIST OF WASHINGTON
1 DIR ARMY LIB PENTAGON
1 STRATEGIC PLANNING GP CORPS OF ENGNR ARMY MAP SERV
1 CHF OF MILIT HIST DA ATTN GEN REF BR
1 CO 24TH ARTY GP (AD) COVENTRY
1 CG 31ST ARTY BRGD AIR DEF OAKDALE PENNA
1 49TH ARTY GP AIR DEF FT LAWTON
2 HQ 4/59TH ARTY REGT NORFOLK
1 28TH ARTY GP AIR DEF SELFRIDGE AFB
1 52D ARTY BRGD AD FT HANCOCK
1 HQ 45TH ARTY BRGD AIR DEF ARLINGTON HTS ILL
1 CG 101ST ABN DIV FT CAMPBELL
1 CG 1ST CAV DIV APO 96490 SAN FRAN
1 US ARMY GEN EQUIP ATTN TECH LIB FT LEE
1 US ARMY TROPIC TEST CTR PO DRAWER 942 ATTN BEHAV SCIENTIST FT CLAYTON
2 CINC US PACIFIC FLT FPO 96614 SAN FRAN
1 CINC US ATLANTIC FLT CODE 312A NORFOLK ATTN LTC DOTY
1 CDR TNG COMMAND US PACIFIC FLT SAN DIEGO
5 TECH LIB PERS 11B BUR OF NAV PERS ARL ANNEX
3 DIR PERS RES DIV BUR OF NAV PERS
1 TECH LIB BUR OF SHIPS CODE 210L NAVY DEPT
1 HUMAN FACTORS BR PSYCHOL RES DIV ONR
1 ENGNR PSYCHOL BR ONR CODE 455 ATTN ASST HEAD WASH DC
3 CO & DIR NAV TNG DEVICE CTR ORLANDO ATTN TECH LIB
1 CO FLT ANTI-AIR WARFARE TNG SAN DIEGO
1 CO NUCLEAR WEAPONS TNG CTR PACIFIC U S NAV AIR STA SAN DIEGO
2 CO FLT TNG CTR NAV BASE NEWPORT
1 CO FLEET TNG CTR U S NAV STA SAN DIEGO
1 CLIN PSYCHOL MENTAL HYGIENE UNIT US NAV ACAD ANNAPOLIS
1 PRES NAV WAR COLL NEWPORT ATTN MAHAN LIB
2 CO & DIR ATLANTIC FLT ANTI-SUB WARFARE TACTICAL SCH NORFOLK
1 CO NUCLEAR WEAPONS TNG CTR ATLANTIC NAV AIR STA NORFOLK
2 CO FLT SONAR SCH KEY WEST
1 CO FLT ANTI-SUB WARFARE SCH SAN DIEGO
1 CHF OF NAV RES ATTN SPEC ASST FOR R & D
1 CHF OF NAV RES ATTN HEAD PERS & TNG BR CODE 458
1 CHF OF NAV RES ATTN HEAD GP PSYCHOL BR CODE 452
1 DIR US NAV RES LAB ATTN CODE 5120
5 CO OFF OF NAV RES BR OFFICE BOX 39 FPO 09510 NY
1 CHF OF NAV AIR TNG TNG RES DEPT NAV AIR STA PENSACOLA
1 CO MED FLD RES LAB CAMP LEJEUNE
1 CDR NAV MSL CTR POINT MUGU CALIF ATTN TECH LIB CODE 3022
1 DIR AEROSPACE CREW EQUIP LAB NAV AIR ENGNR CTR PA
1 OIC NAV PERS RES ACTVY SAN DIEGO
1 NAV NEUROPSYCHIAT RES UNIT SAN DIEGO
2 CDR NAV MSL CTR CODE 5342 POINT MUGU CALIF
1 DIR PERS RES LAB NAV PERS PROGRAM SUPPORT ACTIVITY WASH NAV YD
1 NAV TNG PERS CTR NAV STA NAV YD ANNEX CODE 83 ATTN LIB WASH
1 COMDT MARINE CORPS HQ MARINE CORPS ATTN CODE AO-1B
1 HQ MARINE CORPS ATTN AX
1 DIR MARINE CORPS EDUC CTR MARINE CORPS SCH QUANTICO
1 DIR MARINE CORPS INST ATTN EVAL UNIT
1 CHF OF NAV OPNS OP-01P1
1 CHF OF NAV OPNS OP-03T
1 CHF OF NAV OPNS OP-07T2

50

2 CONDT HQS 8TH NAV DIST ATTN EDUC ADV NEW ORLEANS
1 CHF OF NAV AIR TECH TNG NAV AIR STA MEMPHIS
1 DIR OPS EVAL GRP OFF OF CHF OF NAV OPS OPO3EG
2 CONDT PTP COAST GUARD HQ
1 CHF OFCR PERS RES + REVIEW BR COAST GUARD HQ
1 OPNS ANLS OFC HQ STRATEGIC AIR COND OFFUTT AFB
1 AIR TNG COND RANDOLPH AFB ATTN ATFTM
1 CHF SCI DIV DRCTE SCI + TECH DCS R+D HQ AIR FORCE AFRSTA
1 CHF OF PERS RES BR DRCTE OF CIVILIAN PERS DCS-PERS HQ AIR FORCE
1 CHF ANAL DIV (AFPDPL (R) DIR OF PERSONNEL PLANNING HQS USAF
1 FAA CHF INFO RETRIEVAL BR WASH D.C.
1 HQ AFSC SCDB ANDREWS AFB
2 CDR ELEC TYS DIV L G HANSCOM FLD BEDFORD MASS ATTN ESRHA
1 HQ SAMSO (SMSIR) AF UNIT POST OFC LA AFS CALIF
2 MILIT TNG CTR OPE LACKLAND AFB
2 6570TH AERO MED RES LAB NRPT WRIGHT-PATTERSON AFB
1 AIR MOVEMENT DESIGNATOR AMRH BROOKS AFB
1 HQS ATC DCS/TECH TNG (ATTNS) RANDOLPH AFB
4 HQ AIR TRANS COMD ATCTO-M RANDOLPH AFB
1 CDR ELEC SYS DIV LG HANSCOM FLD ATTN ESTI
1 DIR AIR U LIB MAXWELL AFB ATTN AUL3T-63-253
1 DIR OF LIB US AIR FORCE ACAD
1 CONDT DEF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PATTERSON AFB
1 CONDT ATTN LIB DEF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PATTERSON AFB
1 6570TH PERS RES LAB PRA-4 AEROSPACE MED DIV LACKLAND AFB
1 TECH TNG CTR (LMTC/OP-I-L1) LOWRY AFB
2 AF HUMAN RESOURCES LAB MRHTO WRIGHT-PATTERSON AFB
2 CO HUMAN RESOURCES LAB BROOKS AFB
1 PSYCHOBIOLOGY PROG NATL SCI FOUND
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN TDL
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN DIR OF TNG
5 CIA ATTN OCR/ADD STANDARD DIST
1 SYS EVAL DIV RES DIRECTORATE DOD-OCD PENTAGON
1 DEPT OF STATE BUR OF INTEL + RES EXTERNAL RES STAFF
1 SCI INFO EXCH WASHINGTON
2 CHF MGT & GEN TNG DIV TR 200 FAA WASH DC
1 BUR OF RES & ENGR US POST OFC DEPT ATTN CHF HUMAN FACTORS BR
1 EDUC MEDIA BR OE DEPT OF HEW ATTN T D CLEMENS
1 OFC OF INTERNATL TNG PLANNING & EVAL BR AID WASH DC
1 SYS DEVEL CORP SANTA MONICA ATTN LIB
2 DUNLAP + ASSOC INC DARIEN ATTN LIB
2 RESEARCH ANALYSIS CORP MCLEAN VA 22101
1 RAND CORP WASHINGTON ATTN LIB
1 DIR RAND CORP SANTA MONICA ATTN LIB
2 U OF SO CALIF ELEC PERS RES GP
1 COLUMBIA U ELEC RES LABS ATTN TECH EDITOR
1 MITRE CORP BEDFORD MASS ATTN LIB
2 U OF PGH LEARNING R+D CTR ATTN DIR
1 HUMAN SCI RES INC NORFOLK
1 HUMAN SCI RES INC MCLEAN VA
2 TECH INFO CTR ENGNR DATA SERV N AMER AVN INC COLUMBUS O
1 CHRYSLER CORP MSL DIV DETROIT ATTN TECH INFO CTR
1 RAYTHEON CO ELEC SERV OPNS BURLINGTON MASS
2 EDUC & TNG CONSULTANTS ATTN L C SILVERN LA
1 GEN DYNAMICS POMONA DIV ATTN LIB DIV CALIF
1 AVN SAFETY ENGR & RES DIV OF FLIGHT SAFETY FOUND INC PHOENIX
2 MARQUARDT CORP POMONA CALIF ATTN DEPT 580
1 OTIS ELEVATOR CO DIV ATTN LIB STAMFORD CONN
1 CHF PERS SUBSYS AIRPLANE DIV MS 74-90 RENTON WASH
1 THIOKOL CHEM CORP HUMETRICS DIV LOS ANGELES ATTN LIBN
2 CTR FOR RES IN SOCIAL SYS FLD OFC FT BRAGG
1 INST FOR DEF ANLS RES + ENGNR SUPPORT DIV WASHINGTON
1 HUGHES AIRCRAFT COMPANY CULVER CITY CALIF
1 DIR CTR FOR RES ON LEARNING + TEACHING U OF MICH
1 EDITOR TNG RES ABSTR AMER SOC OF TNG DIRS U OF TENN
1 CTR FOR RES IN SOCIAL SYS AMER U
4 BRITISH EMBSY BRITISH DEF RES STAFF WASHINGTON
3 CANADIAN JOINT STAFF OFC OF DEF RES MEMBER WASHINGTON
3 CANADIAN ARMY STAFF WASHINGTON ATTN GSO2 TNG
3 ACS FOR INTEL FOREIGN LIAISON OFCR TO NORWEG MILIT ATTACHE
1 ARMY ATTACHE ROYAL SWEDISH EMBSY WASHINGTON
1 NATL INST FOR ALCOHOL RES OSLO
1 DEF RES MED LAB ONTARIO
1 OFC OF AIR ATTACHE AUSTRALIAN EMBSY ATTN: T.A. NAVGN WASH, D.C.

1 YORK U DEPT OF PSYCHOL
2 AUSTRALIAN EMBSY OFC OF MILIT ATTACHE WASHINGTON
2 U OF SHEFFIELD DEPT OF PSYCHOL
1 MENNINGER FOUNDATION TOPEKA
1 AMER INST FOR RES SILVER SPRING
1 AMER INST FOR RES PGH ATTN LIBN
1 DIR PRIMATE LAB UNIV OF WIS MADISON
3 MATRIX CORP ALEXANDRIA ATTN TECH LIBN
1 AMER TEL+TEL CO NY
1 U OF GEORGIA DEPT OF PSYCHOL
1 DR GEORGE T MAUTY CHMN DEPT OF PSYCHOL U OF DEL
1 VITRO LABS SILVER SPRING MD ATTN LIBN
1 HEAD DEPT OF PSYCHOL UNIV OF SC COLUMBIA
1 TVA ATTN CHF LABOR RELATIONS BR DIV OF PERS KNOXVILLE
1 U OF GEORGIA DEPT OF PSYCHOL
1 GE CO WASH D C
1 AMER INST FOR RES PALO ALTO CALIF
1 MICH STATE U COLL OF SOC SCI
1 N MEX STATE U
1 ROWLAND + CO HADDONFIELD NJ ATTN PRES
1 OHIO STATE U SCH OF AVN
1 AIRCRAFT ARMAMENTS INC COCKEYSVILLE MD
2 OREGON STATE U DEPT OF MILIT SCI ATTN ADJ
1 TUFTS U HUMAN ENGNR INFO + ANLS PROJ
1 HUMAN FACTORS RES GP WASH U ST LOUIS
1 AMER PSYCHOL ASSOC WASHINGTON ATTN PSYCHOL ABSTR
1 NO ILL U HEAD DEPT OF PSYCHOL
1 BELL TEL LABS INC TECH INFO LIB WHIPPANY LAB NJ ATTN TECH REPORTS LIBN
1 ENGNR LIB FAIRCHILD HILLER REPUBLIC AVN DIV FARMINGDALE N Y
1 WASHINGTON ENGNR SERV CO INC KENSINGTON MD
1 LIFE SCI INC FT WORTH ATTN PRES
1 AMER BEHAV SCI CALIF
1 COLL OF WM + MARY SCH OF EDUC
1 SO ILLINOIS U DEPT OF PSYCHOL
2 COMMUNICABLE DISEASE CTR DEVEL + CONSULTATION SERV SECT ATLANTA
2 WASH MILITARY SYS DIV BETHESDA MD
1 NORTHWESTERN U DEPT OF INDSTR ENGNR
1 HONEYWELL ORD STA MAIL STA 806 MINN
1 NY STATE EDUC DEPT ABSTRACT EDITOR AVCR
1 AEROSPACE SAFETY DIV U OF SOUTHERN CALIF LA
1 MR BRANDON B SMITH RES ASSOC U OF MINN
1 CTR FOR THE ADVANCED STUDY OF EDUC ADMIN ATTN IONE PIERRON U OF OREG
1 A A HEYL ASSOC DIR CAREL WASH DC
1 CHF PROCESSING DIV DUKE U LIB
1 U OF CALIF GEN LIB DOCU DEPT
1 FLORIDA STATE U LIB GIFTS + EXCH
1 HARVARD U PSYCHOL LABS LIB
1 U OF ILL LIB SER DEPT
2 U OF KANSAS LIB PERIODICAL DEPT
1 U OF NEBRASKA LIBS ACQ DEPT
1 OHIO STATE U LIBS GIFT + EXCH DIV
1 PENNA STATE U PATTEE LIB DOCU DESK
1 PURDUE U LIBS PERIODICALS CHECKING FILES
1 STANFORD U LIBS DOCU LIB
1 LIBN U OF TEXAS
1 SYRACUSE U LIB SER DIV
1 U OF MINNESOTA LIB
1 STATE U OF IOWA LIBS SER ACQ
1 NO CAROLINA STATE COLL DH HILL LIB
2 BOSTON U LIBS ACQ DIV
1 U OF MICH LIBS SER DIV
1 BROWN U LIB
2 COLUMBIA U LIBS DOCU ACQ
1 DIR JOINT U LIBS NASHVILLE
2 DIR U LIB GEO WASHINGTON U
2 LIB OF CONGRESS CHF OF EXCH + GIFT DIV
1 U OF PGH DOCU LIBN
1 CATHOLIC U LIB EDUC & PSYCHOL LIB.WASH DC
1 U OF KY MARGARET I KING LIB
1 SO ILL U ATTN LIBN SER DEPT
1 KANSAS STATE U FARRELL LIB
1 BRIGHAM YOUNG U LIB SER SECT
1 U OF LOUISVILLE LIB BELKNAP CAMPUS

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